United States
Department of
Agriculture

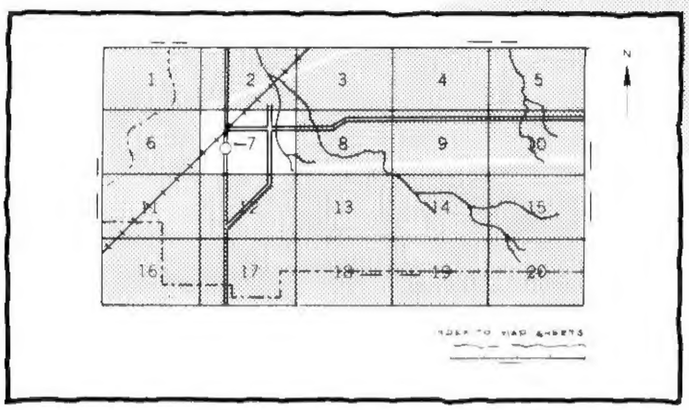
Soil
Conservation
Service

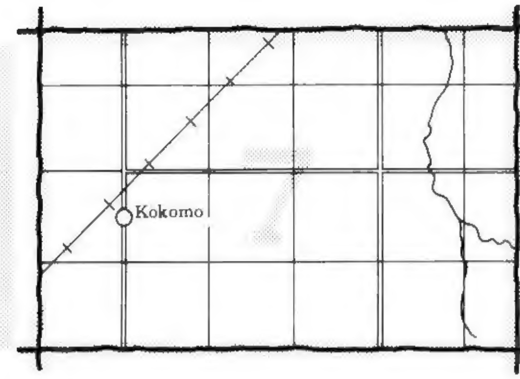
In cooperation with
Purdue University
Agricultural Experiment
Station and
Indiana Department of
Natural Resources,
Soil and Water
Conservation Committee

Soil Survey of Tipton County, Indiana

HOW TO USE

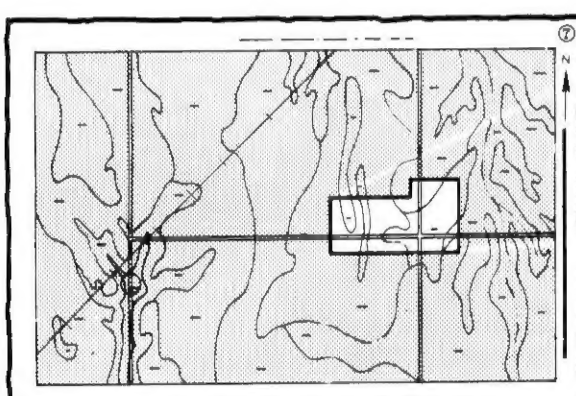
1. Locate your area of interest on the "Index to Map Sheets."

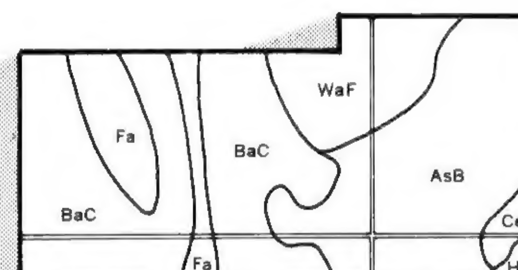




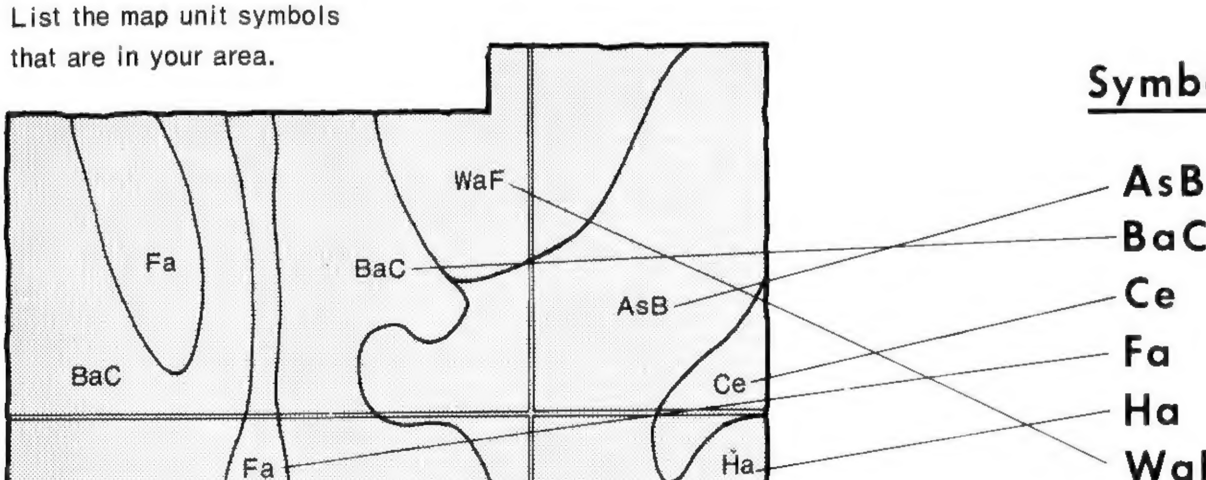
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



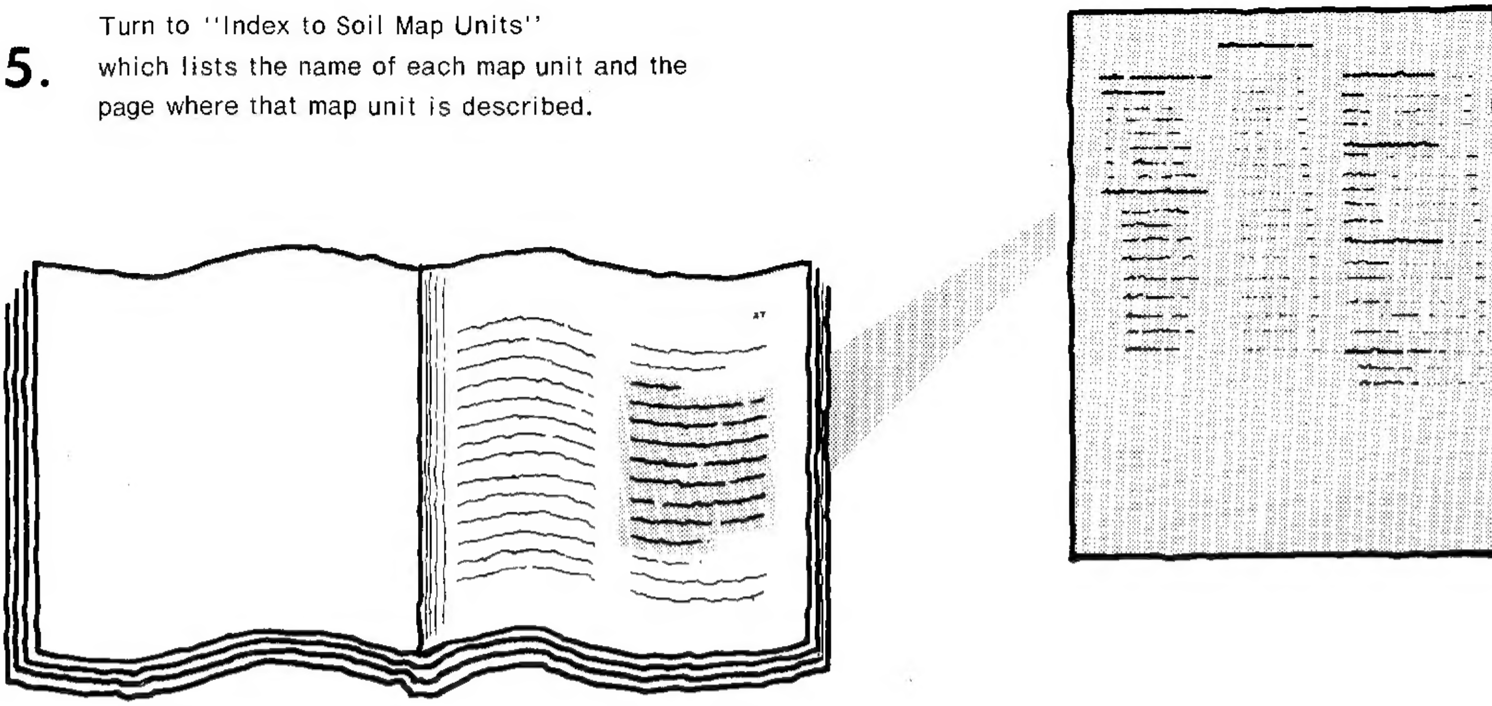


4. List the map unit symbols that are in your area.

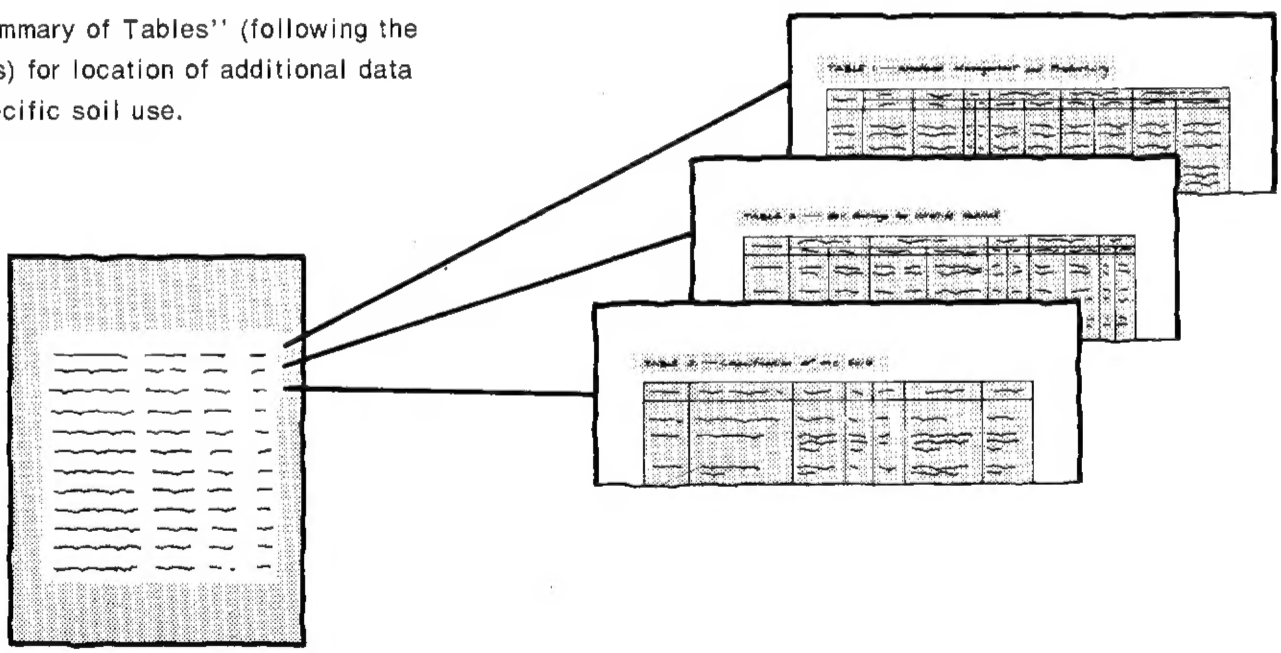


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, handicap, or age.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This survey was made cooperatively by the Soil Conservation Service, the Purdue University Agricultural Experiment Station, and the Indiana Department of Natural Resources, Soil and Water Conservation Committee. It is part of the technical assistance furnished to the Tipton County Soil and Water Conservation District. Financial assistance was provided by the Tipton County Commissioners.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Corn that has been planted on prepared ridges in an area of Del Rey and Crosby soils. Patton soils are in the background.

Contents

Soil Series

Issued April 1989

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Tipton County, Indiana. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Robert L. Eddleman
State Conservationist
Soil Conservation Service

Location of Tipton County in Indiana.

Soil Survey of Tipton County, Indiana

By Travis Neely, Soil Conservation Service

Fieldwork by Travis Neely, Soil Conservation Service, and
Michael Dalton, Indiana Department of Natural Resources,
Soil and Water Conservation Committee

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
Purdue University Agricultural Experiment Station and Indiana Department of Natural Resources, Soil and Water Conservation Committee

TIPTON COUNTY is in the north-central part of Indiana. It has a land area of 166,682 acres, or about 260 square miles. It extends about 13 miles from north to south and 20 miles from east to west. Tipton, the county seat, is in the central part of the county. In 1978, the population of the county was 15,800 (*7*).

Most of the county is farmed. The climate favors cash-grain and livestock farming. Corn, soybeans, and wheat are the chief cash-grain crops. Hogs and beef cattle are the main kinds of livestock. The county has a few truck farms, which are small but productive. Urban development has been slow.

This soil survey updates the survey of Tipton County published in 1914 (*3*). It provides additional information and larger maps, which show the soils in greater detail.

General Nature of the County

This section gives information about the county. It describes history; climate; physiography, relief, and drainage; water supply; transportation facilities; manufacturing and businesses related to agriculture; and trends in land use.

History

Tipton County was originally a hunting ground for the Miami, Delaware, and Potawatomi Indians. In 1826, the Indians ceded all of northwest Indiana, including the land that now makes up Tipton County, to the United States. The first land claim was entered in 1829. The county was established by the Indiana Legislature in 1844. It was one of the last counties in the state to be settled. The southern part of the county was settled first. The earliest settlers came chiefly from Rush, Fayette, Jefferson, and Switzerland Counties. The county was named after General John Tipton, a veteran of the Battle of Tippecanoe and a United States Senator.

The poorly drained, nearly level soils in the county could not be farmed until the wetness was reduced by ditches and tile. The county has been transformed from a swampy prairie and dense forest to one of the most productive agricultural counties in Indiana.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Tipton County is cold in winter and quite hot in summer. Winter precipitation, frequently snow, results in a good accumulation of soil moisture by spring and minimizes drought during summer on most soils. The normal annual precipitation is adequate for all of the crops that are suited to the temperature and growing season in the county.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Frankfort in the period 1951 to 1975. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 27 degrees F, and the average daily minimum temperature is 18

degrees. The lowest temperature on record, which occurred at Frankfort on January 28, 1962, is -23 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which occurred on July 15, 1980, is 105 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 39 inches. Of this, 24 inches, or more than 60 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 19 inches. Tornadoes and severe thunderstorms occur occasionally. These storms are usually local in extent and of short duration and cause damage in scattered areas.

The average seasonal snowfall is 25 inches. On the average, 23 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The sun shines 65 percent of the time possible in summer and 40 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 12 miles per hour, in spring.

Physiography, Relief, and Drainage

Tipton County is on a depositional plain of low relief known as the Tipton Till Plain. Glaciation rather than the underlying bedrock was the chief factor responsible for the landforms in the county. The county was completely covered by ice of the late Wisconsin glacial period. Only slight changes in the landscape were made by post-Wisconsin glacial streams. Relief is strongest along the breaks between the nearly level uplands and the bottom land along the streams that drain the county.

The highest elevation in the county is about 932 feet above sea level. It is in the southwest corner of the county. The lowest elevation, about 830 feet above sea level, is in an area along Duck Creek in the southeast corner of the county.

The northern half of the county is drained generally towards the north by Turkey and Mud Creeks. The water from this part of the county flows into the Wabash River. The southern half of the county is drained generally towards the south by Cicero, Dixon, and Polywog Creeks. These creeks drain into the West Fork of the White River, which eventually empties into the Wabash River. The county has many drainage ditches and smaller streams that outlet into these creeks.

Natural drainage is poor. Marshes and swamps were common before drainage systems were installed. In most areas open ditches and subsurface drains are necessary if crops are grown.

Water Supply

The water for farms, homes, and industry comes from wells that can supply water at an average rate of 400 gallons per minute. The depth to a good source of ground water averages about 75 feet. It ranges from 25 to 150 feet. Public water systems serve Tipton, Windfall, Sharpsville, and Atlanta. All of the public water supplies come from deep wells dug into sand and gravel formations underlying glacial till.

Transportation Facilities

The county has approximately 664 miles of improved roads. The major travel routes are U.S. Highway 31 and State Highways 28, 19, and 213. These highways provide good access to all parts of the county. Two railroad lines serve the county.

Manufacturing and Businesses Related to Agriculture

Tipton has several industries. A few small industries are located in Atlanta, Kempton, Sharpsville, and Windfall. Industry has grown slowly and has not kept up with the number of people in the job market. Therefore, many residents work outside the county.

Most of the grain is marketed through local elevators. It is shipped from these elevators to larger terminals in Indianapolis and then to the Eastern States. Livestock is sold to several markets in the county. It is then shipped to meat packers or to the major market in Indianapolis.

Eight hybrid seed companies operate in the county. The largest of these serves the eastern half of the United States. It is headquartered in Tipton County.

Trends in Land Use

About 83 percent of the county is farmed. The soils are well suited to most farm uses. The number of farms has decreased, but the average size has increased. The county has about 25 farms that are larger than 1,000 acres. Cropping systems are intensive. Row crops are grown year after year on most farms. Corn and soybeans are the chief cash crops. A substantial acreage is used for seed corn. Soft red winter wheat is the most common small grain crop. The county has a few truck farms. Two canning factories process the vegetables grown on these farms.

Some farms raise livestock. Most of the farms specialize in one kind of livestock, mainly hogs. Beef cattle are fairly common, and a few farms raise poultry, dairy cattle, and sheep.

Urban development has been slow in Tipton County. Rapid urban development is occurring only in small areas around Tipton and West Elwood. About 3 percent of the county is urban or built-up land. A small percentage of the farmland has been converted to nonfarm uses in the last 25 to 30 years.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their

properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The names, descriptions, and delineations of the soils identified on the general soil map of this county do not always agree or join with those of the soils identified on the maps of adjoining counties published at an earlier date. Some differences are the result of changes in concepts of soil series. Other differences result from variations in the extent of the soils. Others are the result of variations in the slope range allowed in the associations.

Soil Descriptions

1. Patton-Del Rey-Crosby Association

Nearly level, poorly drained and somewhat poorly drained soils that formed in silty sediments, in silty and sandy sediments, or in a thin mantle of silty material and the underlying loamy and clayey glacial till; on lake plains and till plains

This association is in depressional areas and on slight rises and low flats. The landscape is characterized by very little relief and many depressions. Most areas are artificially drained, and some are drained by small streams. Slopes range from 0 to 2 percent.

This association makes up about 79 percent of the county. It is about 54 percent Patton soils, 24 percent Del Rey soils, 13 percent Crosby soils, and 9 percent minor soils (fig. 1).

Patton soils are poorly drained and are in depressional areas on lake plains and till plains. Typically, the surface soil is very dark gray silty clay loam. The subsoil is gray, mottled, and firm. It is silty clay loam in the upper part and stratified silt loam and silty clay loam in the lower part.

Del Rey soils are somewhat poorly drained and are on low flats on till plains. Typically, the surface layer is dark grayish brown silt loam. The subsoil is brown and grayish brown, mottled, firm silty clay loam.

Crosby soils are somewhat poorly drained and are on slight rises on till plains. Typically, the surface layer is dark grayish brown silt loam. The subsoil is grayish brown, mottled, firm silty clay loam and clay in the upper part and yellowish brown, mottled, firm clay loam in the lower part.

The minor soils in this association are the Palms, Pella, Sisson, Sloan, Strawn, Tuscola, and Williamstown soils. The very poorly drained Palms soils are in depressions and potholes on lake plains. The poorly drained Pella soils are in depressions on till plains and lake plains. The well drained Sisson and moderately well drained Tuscola soils are on breaks along drainageways on lake plains and till plains. The very poorly drained Sloan soils are on flood plains. The well drained Strawn soils are on the slightly higher knobs along drainageways on till plains. The moderately well drained Williamstown soils are on the higher knobs and rises on till plains.

Most of this association has been cleared and drained and is used for corn, soybeans, small grain, or tomatoes. Some areas are used for pasture, hay, or woodland. If drained, the major soils are well suited to corn, soybeans, small grain, and specialty crops and to grasses and legumes for hay and pasture. Wetness is the main limitation, and ponding is the main hazard.

The Patton soils are fairly well suited to trees, and the Crosby and Del Rey soils are well suited. The major management concerns are plant competition on all three soils, seedling mortality and windthrow on the Patton and Del Rey soils, and the equipment limitation on the Patton soils.

The major soils are generally unsuited or poorly suited to dwellings and sanitary facilities, mainly because of wetness and ponding. Slow or moderately slow permeability also is a problem.

2. Pella-Patton-Drummer Association

Nearly level, poorly drained soils that formed in silty sediments or in silty sediments and the underlying loamy

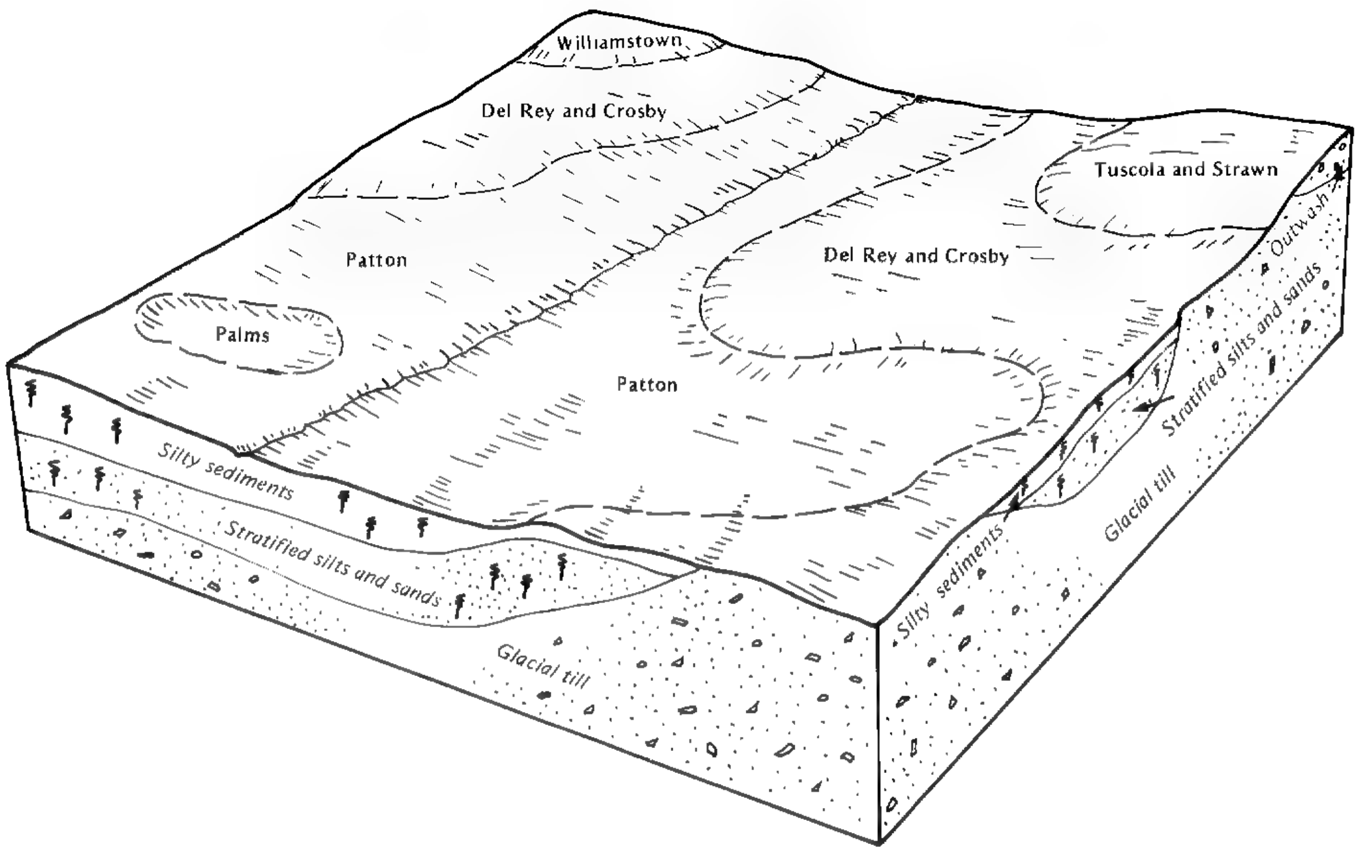

Figure 1.—Pattern of soils and parent material in the Patton-Del Rey-Crosby association.

glacial till; on lake plains and till plains

This association is in broad depressions that generally have little or no relief. Slopes are broken only by a few small drainageways and open ditches. Most areas are drained by subsurface drains, by open ditches, and by the major streams. Slopes range from 0 to 2 percent.

This association makes up about 18 percent of the county. It is about 32 percent Pella soils, 19 percent Patton soils, 17 percent Drummer soils, and 32 percent minor soils.

Pella soils are in the middle of the broad depressions. Typically, the surface soil is black silty clay loam. The subsoil is grayish brown, mottled, firm silty clay loam.

Patton soils are in the middle of the broad depressions. Typically, the surface soil is very dark gray silty clay loam. The subsoil is gray, mottled, and firm. It is silty clay loam in the upper part and stratified silt loam and silty clay loam in the lower part.

Drummer soils are around the outer edge of the broad depressions. Typically, the surface soil is very dark gray silty clay loam. The subsoil is gray, mottled, and firm. It is silty clay loam in the upper part and stratified silty clay loam and loam in the lower part.

The minor soils in this association are the Crosby, Del Rey, Palms, Strawn, Tuscola, and Williamstown soils. The somewhat poorly drained Crosby and Del Rey soils are on slight rises on till plains. The very poorly drained Palms soils are in potholes on lake plains. The well drained Strawn soils are on undulating till plains. The moderately well drained Tuscola soils are on till plains and lake plains. The moderately well drained Williamstown soils are on knobs on till plains.

About 98 percent of the acreage has been cleared. Most of the cleared areas are used for cultivated crops. The major soils are well suited to corn, soybeans, small grain, and specialty crops. Tomatoes and garden crops are grown in small patches in the depressions, on the broad flats, and in a few of the slightly convex areas. The uncleared acreage is swampy wetland that generally supports mixed hardwoods. If drained, the major soils are well suited to grasses and legumes for hay and pasture.

The major soils are generally unsuited to sanitary facilities and dwellings, mainly because of ponding. A better suited alternative site is needed.

3. Sloan-Tuscola-Strawn Association

Nearly level to moderately sloping, very poorly drained, moderately well drained, and well drained soils that formed in alluvium, in stratified silty, loamy, and sandy sediments over loamy glacial till, or in loamy glacial till; on flood plains, lake plains, and till plains

This association is on breaks along drainageways and on lake plains, till plains, and flood plains. The breaks along drainageways and on undulating till plains generally have long, narrow, uneven slopes. The flood plains are long and narrow. They generally are uniform in elevation, but in some areas they are broken by major streams. Most areas are drained by streams, and some are drained by open ditches. Slopes range from 0 to 12 percent.

This association makes up about 3 percent of the county. It is about 32 percent Sloan soils, 18 percent Tuscola soils, 13 percent Strawn soils, and 37 percent minor soils.

Sloan soils are very poorly drained and nearly level. They are on flood plains. Typically, the surface layer is very dark grayish brown silt loam. The subsurface layer is very dark grayish brown silty clay loam. The subsoil is dark gray, mottled, firm silty clay loam.

Tuscola soils are moderately well drained and gently sloping. They are on low rises and long side slopes on till plains and lake plains. Typically, the surface layer is dark brown silt loam. The subsurface layer is dark yellowish brown loam. The subsoil is brown, firm clay loam and sandy clay loam.

Strawn soils are well drained and are gently sloping and moderately sloping. They are on the higher knolls, side slopes, and ridgetops on till plains. Typically, the surface layer is dark yellowish brown loam. The subsoil is dark yellowish brown clay loam.

The minor soils in this association are the Crosby, Del Rey, Patton, Sisson, and Williamstown soils. The somewhat poorly drained Crosby and Del Rey soils are on slight rises and broad flats on till plains. The poorly drained Patton soils are in depressions on lake plains and till plains. The well drained Sisson soils are on side slopes on till plains and lake plains. The moderately well drained Williamstown soils are on low rises and ridgetops on till plains.

About 65 to 75 percent of the acreage has been cleared. Most of the cleared areas on ridgetops, undulating plains, and flood plains are used for cultivated crops. The major soils are fairly well suited or well suited to corn, soybeans, small grain, and specialty crops.

Some small areas on the flood plains are used for hay and pasture. The uncleared acreage supports pasture plants and mixed hardwoods. The major soils are well suited to grasses and legumes for hay and pasture. The slope and the hazard of erosion are the main management concerns in areas of the Strawn and Tuscola soils. Flooding is the main hazard on the Sloan soils.

The major soils are suitable for trees. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, or girdling.

The major soils are generally unsuited or poorly suited to sanitary facilities because of flooding, restricted permeability, and wetness. The Tuscola soils are only fairly well suited or poorly suited to dwellings because of the wetness, the Sloan soils are generally unsuited because of the flooding and the wetness, and the Strawn soils are well suited.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Williamstown silt loam, 1 to 4 percent slopes, is a phase of the Williamstown series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Tuscola, till substratum-Strawn complex, 1 to 6 percent slopes, eroded, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

The names, descriptions, and delineations of the soils identified on the detailed soil maps of this county do not always agree or join with those of the soils identified on the maps of adjoining counties published at an earlier date. Some differences are the result of changes in concepts of soil series. Other differences result from variations in the extent of the soils. Others are the result of variations in the slope range allowed in the map units.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

DeA—Del Rey, sandy substratum-Crosby silt loams, 0 to 2 percent slopes. These nearly level, deep, somewhat poorly drained soils are on till plains. The Del Rey soil is on the broader, less sloping parts of the landscape. The Crosby soil is on the higher rises and in the more sloping areas along drainageways. Areas generally are irregularly shaped, but some are elongated. The areas are 3 to 80 acres in size. The dominant size is about 15 acres. This map unit is about 55 percent Del Rey and 30 percent Crosby soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Del Rey soil has a surface layer of dark grayish brown silt loam about 12 inches thick. The subsoil is brown and grayish brown, mottled, firm silty clay loam about 23 inches thick. The upper part of the substratum is brown silty clay loam that has thin strata of silt loam. The lower part to a depth of about 60 inches is brown loamy fine sand that has thin strata of silt loam. In some areas the solum is more than 48 inches thick. In a few areas the subsoil has less clay. In places the substratum is very fine sand and loamy sand.

Typically, the Crosby soil has a surface layer of dark grayish brown silt loam about 9 inches thick. The subsoil is about 26 inches thick. It is mottled and firm. The upper part is grayish brown silty clay loam and clay, and the lower part is yellowish brown clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, firm loam. In some places, the silty mantle is

more than 14 inches thick and the upper part of the subsoil has less sand. In other places the soil has a slope of more than 2 percent and is moderately eroded. In some small areas the solum is more than 40 inches thick. In a few areas the subsoil has less clay.

Included with these soils in mapping are the poorly drained Drummer, Patton, and Pella soils in depressions and the well drained Sisson and Strawn and moderately well drained Tuscola and Williamstown soils on the slightly higher knobs and rises. Also included are small areas of soils on the steeper slopes adjacent to streams. Included soils make up about 15 percent of the map unit.

The Del Rey soil is slowly permeable in the subsoil and rapidly permeable in the substratum. The Crosby soil is slowly permeable in the subsoil and slowly permeable or moderately slowly permeable in the substratum. The available water capacity of both soils is high. Surface runoff is slow. The water table is at a depth of 1 to 3 feet during the winter and early spring. The organic matter content is moderately low in the surface layer. This layer is friable and can be tilled throughout a fairly wide range in moisture content.

Most areas of these soils are used for cultivated crops. Some are used for hay or pasture, and a few are used for orchards, woodland, or specialty crops. Some areas in the central and northern parts of the county have been developed for urban uses.

If drained, these soils are well suited to corn, soybeans, small grain, and tomatoes. The wetness is the main limitation. Most areas are drained by subsurface drains, surface drains, or a combination of these. Winter cover crops and a system of conservation tillage that leaves protective amounts of crop residue on the surface help to maintain the organic matter content and good tilth. The soils are well suited to ridge-till farming and to fall chiseling.

If drained, these soils are well suited to grasses and legumes, such as orchardgrass and ladino clover, for hay and pasture. They are not so well suited to deep-rooted legumes, such as alfalfa, as to shallow-rooted forage species. Overgrazing or grazing under wet conditions causes surface compaction and poor tilth. Proper stocking rates, rotation grazing, timely deferment of grazing, and restricted use during wet periods minimize surface compaction and help to maintain good tilth and plant density.

These soils are well suited to trees. Seedling mortality, windthrow, and plant competition are the main management concerns. Harvest methods that do not isolate the remaining trees or leave them widely spaced help to prevent windthrow. Seedlings survive and grow well if competing vegetation is controlled by proper site preparation and by cutting, spraying, or girdling. Some replanting generally is necessary. The high water table hinders harvesting and planting.

Because of the wetness, these soils are severely limited as sites for dwellings. A drainage system can lower the water table. Water moves slowly to drainage systems because of the slow permeability. Dwellings should be constructed without basements.

These soils are severely limited as sites for local roads and streets because of frost action and low strength. Roadside ditches help to remove excess water and thus minimize the damage caused by frost action. Strengthening or replacing the base material improves the capacity of the roads and streets to support vehicular traffic.

Because of the wetness and the slow permeability, these soils are severely limited as sites for septic tank absorption fields. Installing subsurface drains around the outer edge of the absorption field helps to remove excess water. Filling or mounding with better suited material improves the capacity of the field to absorb the effluent.

The land capability classification is IIw. The woodland ordination symbol assigned to the Del Rey soil is 4C, and that assigned to the Crosby soil is 4A.

Pa—Palms muck, drained. This nearly level, deep, very poorly drained soil is in potholes along drainageways on lake plains (fig. 2). It is ponded by surface runoff from the adjacent soils. Areas are round or are long and narrow. They are 5 to about 200 acres in size. The dominant size is about 50 acres.

Typically, the surface layer is black muck about 14 inches thick. The next layer is black, very friable muck about 10 inches thick. The substratum to a depth of about 60 inches is gray silt loam. It has strata of sandy loam in the lower part. In places the substratum is marl and loamy or sandy material. In some areas the organic material is more than 30 or less than 16 inches thick. In other areas the surface layer is mucky silt loam.

Included with this soil in mapping are the mineral, poorly drained Drummer, Patton, and Pella soils at the slightly higher elevations around the edges of the mapped areas. Also included are a few small areas of organic soils that are more acid than the Palms soil and are underlain by clay and sand and a few areas of the undrained Palms soils. Included soils make up about 6 percent of the map unit.

Permeability is moderately slow to moderately rapid in the organic part of the Palms soil and moderately slow or moderate in the mineral part. The available water capacity is very high. Surface runoff is very slow or ponded. The water table is near or above the surface from late in the fall to early in summer. The organic matter content is very high in the surface layer. This layer is friable and can be easily tilled.

Most areas are used for cultivated crops, mainly corn. If drained, this soil is fairly well suited to corn, soybeans, and truck crops. It is subject to wind erosion and ponding. Also, it warms up slowly in spring and is very unstable. The ponding hinders the use of equipment. Machinery bogs down in the organic material. Operating

Figure 2.—An area of Palms muck, drained.

heavy equipment is hazardous, especially near drainage ditches. Open ditches, subsurface drains, pumps, or a combination of these can remove excess water and allow the soil to warm up sooner in spring. Management of the water table determines the rate of oxidation in the organic material. Excessive drainage increases the rate of subsidence. Wind erosion can be controlled by windbreaks, crop residue management, conservation tillage, or a permanent cover of vegetation.

This soil is well suited to grasses, such as reed canarygrass, for hay and pasture. Overgrazing or grazing during wet periods reduces plant density and plant hardiness. Proper stocking rates, rotation grazing, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

A few small areas are wooded. This soil is poorly suited to trees. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are severe. Undesirable vegetation can be controlled or removed by proper site preparation and by spraying, cutting, or girdling. Water-tolerant species should be favored in the stands. Trees generally can be harvested only when the ground is frozen. Harvest methods that do not isolate the remaining trees or leave them widely spaced help to prevent windthrow.

Because of ponding, low strength, and subsidence, this soil is generally unsuitable as a site for dwellings and sanitary facilities. It is severely limited as a site for local roads and streets because of ponding, frost action, and subsidence. Replacing the unstable organic material with suitable base material minimizes frost action and subsidence and improves the ability of the roads and streets to support vehicular traffic. Roadside ditches minimize the damage caused by ponding.

The land capability classification is IIIw. The woodland ordination symbol is 2W.

Pc—Palms muck, undrained. This nearly level, deep, very poorly drained soil is in potholes on lake plains. It is ponded by surface runoff from the adjacent soils. Areas are dominantly about 10 acres in size.

Typically, the surface layer is black muck about 10 inches thick. The next layer also is black muck. It is about 8 inches thick. The substratum to a depth of about 60 inches is gray, mottled, firm sandy loam that has strata of silt loam and very fine sand. In many small areas the organic material is more than 30 inches thick. In many places the substratum is marl and loamy or sandy material.

Included with this soil in mapping are the mineral, poorly drained Drummer and Patton soils at the slightly higher elevations around the edges of the mapped areas. These soils make up about 4 percent of the map unit.

Permeability is moderately slow to moderately rapid in the organic part of the Palms soil and moderately slow or moderate in the mineral part. The available water capacity is very high. Surface runoff is very slow or ponded. The water table is near or above the surface from October through June in most years. In some years it is near or above the surface for the entire year. The organic matter content is very high in the surface layer.

Most areas are used as wildlife habitat. This soil is well suited to wetland wildlife habitat but is generally unsuited to other uses. It provides cover for more than 150 species of wildlife. Many ducks, geese, and other birds depend on these protected wetlands for nesting and feeding sites. Timber is grown in some areas.

Because of ponding and low strength, this soil is generally unsuitable as a site for dwellings and sanitary facilities. It is severely limited as a site for local roads and streets because of ponding, frost action, and subsidence. Replacing the unstable organic material with suitable base material minimizes frost action and subsidence. Roadside ditches minimize the damage caused by ponding.

The land capability classification is Vw. The woodland ordination symbol is 2W.

Pn—Patton silty clay loam, sandy substratum. This nearly level, deep, poorly drained soil is in depressions on lake plains and till plains. It is often ponded by surface runoff from the adjacent soils. Areas generally are irregular in shape, but some in drainageways are elongated. The areas are 10 to 400 acres in size. The dominant size is about 75 acres.

Typically, the surface layer is very dark gray silty clay loam about 9 inches thick. The subsurface layer also is very dark gray silty clay loam. It is about 3 inches thick. The subsoil is about 43 inches thick. The upper part is gray, mottled, firm silty clay loam, and the lower part is mottled gray and yellowish brown silty clay loam that has strata of silt loam. The substratum to a depth of about 60 inches is light olive brown silt loam that has thin strata of sandy loam and loamy sand. In some areas the solum is less than 45 inches thick. In a few areas the subsoil has more clay and less silt. In places the surface layer is silty clay.

Included with this soil in mapping are the somewhat poorly drained Crosby and Del Rey soils on the slightly higher rises. Also included are the mucky, very poorly drained Palms soils in the deeper depressions and potholes. Included soils make up about 7 percent of the map unit.

Permeability is moderately slow or moderate in the subsoil of the Patton soil and moderate in the substratum. The available water capacity is high. Surface runoff is very slow or ponded. The water table is near or above the surface during winter and early spring. The organic matter content is high in the surface layer.

Most areas of this soil are used for cultivated crops. A few areas are used for specialty crops, hay, pasture, or woodland. Some undrained areas are idle and support mainly wetland weeds.

If drained, this soil is well suited to corn, soybeans, small grain, and tomatoes. The ponding is the main hazard. Most areas are drained by subsurface drains, surface drains (fig. 3), or a combination of these. If tilled when too wet, the surface layer becomes cloddy and cannot be easily worked. If plowed or chiseled in the fall, the soil can be more easily tilled the following spring. A system of conservation tillage that leaves protective amounts of crop residue on the surface improves tilth and helps to maintain the organic matter content. The soil is well suited to ridge-till farming and to till-plant cropping systems.

This soil is well suited to grasses and legumes, such as orchardgrass and ladino clover, for hay and pasture. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Overgrazing also reduces plant density and plant hardiness. Proper stocking rates, timely deferment of grazing, and restricted use during wet periods minimize surface compaction and help to maintain good tilth and plant density.

This soil is fairly well suited to trees. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. Harvesting and logging are restricted to dry periods or to winter

Figure 3.—A surface drain in an area of Patton silty clay loam, sandy substratum.

months, when the ground is frozen. Special site preparation, such as bedding, is needed in some areas. Harvest methods that do not isolate the remaining trees or leave them widely spaced help to prevent windthrow. Competing vegetation can be controlled by spraying, cutting, or girdling.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. It is severely limited as a site for local roads and streets because of low strength, ponding, and frost action. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Building the roads on raised, well compacted fill material

and providing roadside ditches and culverts help to prevent the damage caused by ponding and frost action.

The land capability classification is IIw. The woodland ordination symbol is 5W.

Ps—Pella, sandy substratum-Drummer, till substratum, silty clay loams. These nearly level, deep, poorly drained soils are in the deeper depressions on broad lake plains and till plains. They are often ponded by surface runoff from the adjacent areas. The Pella soil generally is in the center of the depressions. The Drummer soil generally is near the outer edges, on the higher parts of the depressions. Areas are mainly oval and range from 50 to 640 acres in size. They are about 60 percent Pella soil and 35 percent Drummer soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the Pella soil has a surface layer of black silty clay loam about 11 inches thick. The subsurface layer also is black silty clay loam. It is about 3 inches thick. The subsoil is grayish brown, mottled, firm silty clay loam about 14 inches thick. The upper part of the substratum is light brownish gray, mottled silt loam. The next part is grayish brown, mottled silt loam that has strata of loamy sand. The lower part to a depth of about 60 inches is grayish brown, mottled silt loam that has strata of loamy sand and sand. In some small areas the depth to the substratum is more than 40 inches. In places the surface layer is silty clay. In a few areas the soil has gravel and sand in the substratum.

Typically, the Drummer soil has a surface layer of very dark gray silty clay loam about 10 inches thick. The subsurface layer also is very dark gray silty clay loam. It is about 3 inches thick. The subsoil is about 37 inches thick. It is gray, mottled, and firm. The upper part is silty clay loam, and the lower part is stratified silty clay loam and loam. The substratum to a depth of about 60 inches is mottled gray and yellowish brown loam. In some small areas the depth to the substratum is less than 40 inches. In some areas the surface layer is silty clay. In a few places the soil has gravel and sand in the substratum. In a few areas the subsoil has more clay.

Included with these soils in mapping are the somewhat poorly drained Crosby and Del Rey soils on the slightly higher rises and the very poorly drained, organic Palms soils in potholes. Included soils make up about 5 percent of the map unit.

Permeability is moderate in the Pella soil. It is moderate in the subsoil of the Drummer soil and moderately slow in the substratum. The available water capacity of both soils is high. Surface runoff is slow to ponded. The water table is near or above the surface during winter and early spring. The organic matter content is high in the surface layer. If tilled when too wet, this layer becomes cloddy and cannot be easily worked.

Most areas of these soils are used for cultivated crops. Some are used for hay, pasture, or specialty crops. A few are used as wildlife habitat or woodland.

If drained, these soils are well suited to corn, soybeans, small grain, and tomatoes. The ponding is the major hazard. Most areas are drained by subsurface drains, surface drains, or a combination of these. A system of conservation tillage that leaves protective amounts of crop residue on the surface improves tilth and helps to maintain the organic matter content. The soils are well suited to ridge-till farming, to till-plant cropping systems, and to fall plowing and fall chiseling.

If drained, these soils are well suited to grasses and legumes for hay and pasture. Orchardgrass and ladino clover grow well, but deep-rooted legumes, such as alfalfa, grow poorly because of the high water table. Overgrazing or grazing when the soils are too wet causes surface compaction and poor tilth. Overgrazing also reduces plant density and plant hardiness. Proper stocking rates, timely deferment of grazing, and restricted use during wet periods minimize surface compaction, improve tilth, and help to maintain good plant density.

Because of the ponding, these soils are generally unsuitable as sites for dwellings and sanitary facilities. They are severely limited as sites for local roads because of low strength, ponding, and frost action. Constructing the roads on raised, well compacted fill material and providing roadside ditches and culverts help to prevent the damage caused by the ponding and frost action. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength.

The land capability subclass is IIw. No woodland ordination symbol is assigned.

SaC2—Sisson-Strawn complex, 6 to 12 percent slopes, eroded. These moderately sloping, deep, well drained soils are on till plains and lake plains. The Strawn soil is on the higher parts of the landscape, and the Sisson soil is on low rises and long side slopes. Areas are narrow and irregular in shape and are 3 to 12 acres in size. The dominant size is about 8 acres. This map unit is about 50 percent Sisson soil and 35 percent Strawn soil. The two soils occur as areas so intricately mixed that separating them in mapping was not practical.

Typically, the Sisson soil has a surface layer of dark yellowish brown loam about 7 inches thick. This layer is mixed with brown clay loam from the subsoil. The subsoil is brown and dark brown, firm clay loam about 28 inches thick. The substratum to a depth of about 60 inches is yellowish brown. It is stratified silt loam and sandy loam in the upper part and stratified sand and loamy sand in the lower part. In some places the soil has a thinner subsoil and is shallower to calcareous material. In other places the surface layer is clay loam or sandy loam.

Typically, the Strawn soil has a surface layer of dark brown clay loam about 7 inches thick. The subsoil is dark yellowish brown, firm clay loam about 11 inches thick. The substratum to a depth of about 60 inches is yellowish brown loam. In some small areas the solum is more than 22 inches thick. In a few areas the subsoil has more clay. In places the surface layer is silt loam or loam.

Included with these soils in mapping are Del Rey, Sloan, and Williamstown soils. The somewhat poorly drained Del Rey soils are on slight rises. The very poorly drained Sloan soils are on bottom land. The moderately well drained Williamstown soils are on the slightly lower knobs. Also included are scattered areas where the slope is significantly more than 12 percent. Included soils make up about 3 percent of the map unit.

Permeability is moderate in the Sisson soil. It is moderate in the subsoil of the Strawn soil and moderately slow in the substratum. The available water capacity is high in the Sisson soil and moderate in the Strawn soil. Surface runoff is rapid on both soils. The organic matter content is low in the surface layer. This layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of these soils are used for cultivated crops. Some are used for pasture, hay, or woodlots. A few small areas are used for tomatoes.

These soils are fairly well suited to corn, soybeans, small grain, and tomatoes. Erosion is the main hazard. If the soils are cultivated, measures that control surface runoff and erosion are needed. Examples are diversions, grassed waterways, grade stabilization structures, and a cropping system that includes grasses and legumes. Cover crops and a system of conservation tillage that leaves protective amounts of crop residue on the surface help to control erosion and maintain tilth and the organic matter content. The soils are well suited to no-till and till-plant cropping systems.

These soils are well suited to grasses and legumes, such as orchardgrass and alfalfa, for hay and pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soils are too wet causes surface compaction and poor tilth. Proper stocking rates, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

A few areas are wooded. These soils are well suited to trees. Plant competition is moderate. It can be controlled by proper site preparation and by spraying, cutting, or girdling.

These soils are moderately limited as sites for dwellings because of the slope of both soils and the shrink-swell potential of the Sisson soil. Properly designing foundations helps to prevent the structural damage caused by shrinking and swelling. The dwellings should be designed so that they conform to the natural slope of the land. Otherwise, extensive land shaping may be necessary. Erosion is a hazard on construction sites. It can be controlled by developing random lots rather than extensive areas, by retaining as much of the existing vegetation as possible, by building local roads and streets on the contour, by establishing diversions that intercept the runoff between lots, and by stockpiling topsoil and then using it as the final cover.

The Sisson soil is severely limited as a site for local roads and streets because of low strength, and the Strawn soil is moderately limited because of slope, frost action, and low strength. Some road cuts may be necessary. Strengthening or replacing the base with better suited fill material helps to prevent the damage caused by low strength and frost action.

The Sisson soil is moderately limited as a site for septic tank absorption fields because of the restricted permeability and the slope, and the Strawn soil is severely limited because of the restricted permeability. Land shaping and installing the distribution lines across the slope help to ensure that the absorption field functions properly. Filling or mounding with suitable material improves the capacity of the field to absorb the effluent.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

Sh—Sloan silt loam, sandy substratum, occasionally flooded. This nearly level, deep, very poorly drained soil is on flood plains. Areas are long and narrow and are 3 to 35 acres in size. The dominant size is about 10 acres.

Typically, the surface layer is very dark grayish brown silt loam about 12 inches thick. The subsurface layer is very dark grayish brown, mottled silty clay loam about 10 inches thick. The subsoil is dark gray, mottled, firm silty clay loam about 8 inches thick. The upper 15 inches of the substratum is dark gray clay loam. The lower part to a depth of about 60 inches is dark gray fine sand that has thin strata of silt loam and silty clay loam. In some areas the solum is more than 40 inches thick. In a few areas the surface layer is lighter colored. In places the subsoil and substratum are loamy very fine sand and coarse sand.

Included with this soil in mapping are the well drained Sisson and Strawn soils on side slopes. These soils make up about 8 percent of the map unit.

Permeability is moderate or moderately slow in the upper part of the Sloan soil and rapid in the lower part of the substratum. The available water capacity is high. Surface runoff is very slow or ponded. The water table is at or near the surface during winter and early spring. The organic matter content is moderate in the surface layer. This layer is friable and can be easily tilled throughout a moderate range in moisture content. Tilling when the soil is too dry or too wet results in a cloddy seedbed.

Most areas are used as pasture or woodland. A few are drained and are used for corn or soybeans. If

drained, this soil is fairly well suited to corn and soybeans, which can be planted and harvested when the hazard of flooding is least severe. Some areas between streams are too narrow for cropping. A drainage system is needed in most areas. Land smoothing and shallow surface drains help to remove excess surface water. In some areas flooding can be controlled by field ditches and by properly located diversions that can intercept runoff from the higher adjacent slopes. A system of conservation tillage that leaves protective amounts of crop residue on the surface, cover crops, and green manure crops help to maintain tilth and the organic matter content. The soil is well suited to ridge-till farming if the rows follow the direction of natural drainage and streamflow. The ridges can be prepared only in the spring.

This soil is well suited to some grasses and legumes for hay or pasture, but the flooding may damage these plants in winter and early in spring. The soil is poorly suited to deep-rooted legumes, such as alfalfa, because of the high water table. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, rotation grazing, timely deferment of grazing, and restricted use during wet periods minimize surface compaction and help to maintain good tilth and plant density.

Some areas are wooded. This soil is fairly well suited to trees. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The prolonged seasonal wetness hinders harvesting and planting. Equipment can be used only when the soil is relatively dry or frozen. The seedling mortality rate can be reduced by selecting the larger, older seedlings for planting and by increasing plant density. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. The best suited species are those that can withstand the wetness. Competing vegetation can be controlled by cutting, spraying, or girdling.

Because of the flooding, this soil is generally unsuitable as a site for dwellings and septic tank absorption fields. It is severely limited as a site for local roads and streets because of low strength, wetness, and flooding. Frost action also is a problem. Providing coarse grained subgrade or base material helps to prevent the damage caused by low strength. Building the roads on raised, well compacted fill material above the level of flooding and providing roadside ditches and culverts minimize the damage caused by wetness, frost action, and flooding.

The land capability classification is IIIw. The woodland ordination symbol is 5W.

TuB2—Tuscola, till substratum-Strawn complex, 1 to 6 percent slopes, eroded. These gently sloping, deep soils are on till plains and lake plains. The moderately well drained Tuscola soil is on low rises, and the well drained Strawn soil is on the higher parts of the landscape. Areas are narrow and irregular in shape and are 3 to 15 acres in size. The dominant size is about 10 acres. This map unit is about 50 percent Tuscola soil and 35 percent Strawn soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Tuscola soil has a surface layer of dark brown silt loam about 8 inches thick. The next layer is brown loam about 7 inches thick. The subsoil is about 28 inches thick. It is brown and firm. It is clay loam in the upper part and sandy loam in the lower part. The upper part of the substratum is dark yellowish brown loamy sand. The next part is yellowish brown, stratified very fine sand and silt loam. The lower part to a depth of about 60 inches is yellowish brown loam. In some small areas the solum is less than 40 inches thick. In a few areas the subsoil has more clay. In places the surface layer is loam or sandy loam.

Typically, the Strawn soil has a surface layer of brown loam about 8 inches thick. The subsoil is dark yellowish brown, firm clay loam about 10 inches thick. The substratum to a depth of about 60 inches is yellowish brown loam. In some small areas the solum is more than 22 inches thick. In a few areas the subsoil has more clay.

Included with these soils in mapping are Crosby, Del Rey, Sloan, and Williamstown soils. The somewhat poorly drained Crosby and Del Rey soils are on the less sloping, slightly lower parts of the landscape. The very poorly drained Sloan soils are on bottom land. The moderately well drained Williamstown soils are on the slightly higher knobs. Also included are areas where the slope is significantly more than 6 percent. These areas are adjacent to large streams. Included soils make up about 15 percent of the map unit.

Permeability is moderate in the subsoil of the Tuscola and Strawn soils and moderately slow in the substratum. The available water capacity is high in the Tuscola soil and moderate in the Strawn soil. Surface runoff is medium on both soils. The Tuscola soil has a water table at a depth of 2 to 4 feet during winter and early spring. The organic matter content is moderately low in the surface layer of both soils. This layer is friable and can be tilled throughout a fairly wide range in moisture content.

Most areas of these soils are used for cultivated crops. Some are used for pasture, hay, or woodlots. A few small areas are used for tomatoes.

These soils are well suited to corn, soybeans, and small grain, and tomatoes. Erosion is the main hazard if cultivated crops are grown. Cropping systems that include grasses and legumes, water- and sediment-control basins, diversions, stripcropping, grassed waterways, and grade stabilization structures help to prevent excessive soil loss. A system of conservation tillage that leaves protective amounts of crop residue on

the surface helps to control erosion and helps to maintain tilth and the organic matter content. The soils are well suited to no-till and till-plant cropping systems. Subsurface drains are needed in seepy areas in drainageways and swales.

These soils are well suited to grasses and legumes, such as orchardgrass and alfalfa, for hay and pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soils are too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotation grazing, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

A few areas are wooded. These soils are well suited to trees. Plant competition is moderate. It can be controlled by proper site preparation and by cutting, spraying, or girdling.

The Strawn soil is suitable as a site for dwellings. Because of the wetness and the shrink-swell potential, the Tuscola soil is moderately limited as a site for dwellings without basements. It is severely limited as a site for dwellings with basements because of the wetness. Subsurface drains help to lower the water table. Properly designing the foundations of dwellings without basements and backfilling around footings and foundations with coarse textured material help to prevent the structural damage caused by shrinking and swelling. Some land shaping may be needed. Erosion is a hazard on construction sites. It can be controlled by retaining as much of the existing vegetation as possible, by stockpiling topsoil and then using it as the final cover, and by reseeding desirable grasses as soon as possible after construction is complete.

The Tuscola soil is severely limited as a site for local roads and streets because of low strength, and the Strawn soil is moderately limited because of frost action and low strength. Strengthening the base with better suited material improves the capacity of the roads and streets to support vehicular traffic and minimizes frost action.

The Tuscola soil is severely limited as a site for septic tank absorption fields because of the wetness and the moderately slow permeability, and the Strawn soil is severely limited because of the moderately slow permeability. Installing subsurface drains around the edge of the absorption field helps to remove excess water. Filling or mounding with suitable material improves the capacity of the field to absorb the effluent.

The land capability classification is IIe. The woodland ordination symbol assigned to the Tuscola soil is 5A, and that assigned to the Strawn soil is 4A.

Ud—Udorthents, loamy. These nearly level to very steep, shallow to deep, well drained to very poorly drained soils are in disturbed areas on till plains, lake plains, and flood plains. They are around gravel pits, landfills, and factories. In some places, deep cuts have been made in the original land surface and the removed soil material has been used as fill in the lower areas. Adding fill in these areas has resulted in a smoother, more nearly level surface. In some areas the soil material was removed for use as fill on highway grades. Many borrow areas are filled with water and are used for various types of wildlife habitat. Areas are circular, oval, or irregular in shape and are 3 to 25 acres in size. The dominant size is about 10 acres.

Typically, the soil material is a mixture of the surface soil, subsoil, and substratum of the original soils. It is silt loam, loam, clay loam, or silty clay loam. In some areas it has some sand and gravel or stones. In areas where a deep cut has been made, the material is mainly loamy glacial till or gravelly sand.

Included with these soils in mapping are small areas where slopes are short and steep; areas of sand and gravel or stones; a few areas where muck underlies fill material; and some areas where the fill is rocks, glass, metal, and other discarded material.

These soils are moderately permeable to very slowly permeable. The available water capacity is moderate. Surface runoff is very rapid to very slow. The organic matter content is low. Reaction ranges from medium acid to moderately alkaline.

Most areas support a permanent cover of grasses and low-growing shrubs and are used as wildlife habitat. Access to these areas is limited. Many areas are surrounded by heavily traveled highways. Special management is needed in all areas. An intensified fertilization program with special emphasis on the use of organic material or manure is needed if cultivated crops are grown. Measures that control erosion are needed in the gently sloping to steep areas. Examples are diversions, box inlet structures, grade stabilization structures, and grassed waterways. Exposed areas should be revegetated as soon as possible after construction. A drainage system is needed in some of the nearly level areas.

If these soils are used as sites for dwellings, onsite investigation is needed to determine the soil-related limitations. These limitations include wetness and restricted permeability in the nearly level areas and slope and restricted permeability in the steeper areas. The potential for frost action should be considered. Because the soil material varies, engineering tests are needed. Erosion is a hazard on construction sites. It can be controlled by removing as little vegetation as possible and by establishing a protective plant cover as soon as possible after construction is completed.

No land capability classification or woodland ordination symbol is assigned.

WkB—Williamstown silt loam, 1 to 4 percent slopes. This gently sloping, deep, moderately well drained soil is on till plains. Areas generally are irregular

in shape, but some are elongated. The areas are 3 to 35 acres in size. The dominant size is about 10 acres.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsurface layer is brown silt loam about 9 inches thick. The subsoil is about 21 inches thick. The upper part is yellowish brown, mottled, friable clay loam; the next part is brown, mottled, firm clay loam; and the lower part is yellowish brown, mottled, firm loam. The substratum to a depth of about 60 inches is yellowish brown loam. In some areas the soil has a slope of more than 6 percent and is severely eroded. In some small areas the solum is less than 20 inches thick. In places the surface layer is clay loam.

Included with this soil in mapping are the somewhat poorly drained Crosby and Del Rey soils in slightly convex areas, the well drained Strawn soils on the higher knolls and ridgetops, and small areas of soils that stay wet for extended periods and generally are not farmed. Also included are small areas where the slope is significantly more than 4 percent. These areas are adjacent to streams. Included soils make up about 5 percent of the map unit.

Permeability is moderate in the subsoil of the Williamstown soil and moderately slow in the substratum. The available water capacity is moderate. Surface runoff is medium. The water table is at a depth of 1.5 to 3.5 feet during winter and early spring. The organic matter content is moderately low in the surface layer. This layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are used for cultivated crops. Some small areas are used for pasture, hay, or specialty crops. A few small areas are wooded.

This soil is well suited to corn, soybeans, small grain, and tomatoes. If cultivated crops are grown, erosion is the main hazard. It can be controlled by cropping systems that include grasses and legumes, water- and sediment-control basins, diversions, stripcropping, grassed waterways, and grade stabilization structures. A system of conservation tillage that leaves protective amounts of crop residue on the surface throughout most of the year helps to control erosion, improves tilth, and increases the organic matter content. The soil is well suited to no-till and till-plant cropping systems. Subsurface drains are needed in seepy areas in small drainageways and swales.

This soil is well suited to grasses and legumes, such as orchardgrass and alfalfa, for hay and pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotation grazing, and timely deferment of grazing help to keep the pasture in good condition.

This soil is well suited to trees. Plant competition is moderate. It can be controlled by cutting, spraying, or girdling.

Because of the wetness and the shrink-swell potential, this soil is moderately limited as a site for dwellings without basements. It is severely limited as a site for dwellings with basements because of the wetness. A drainage system is needed to lower the water table. Water moves slowly to drainage systems because of the moderately slow permeability. Strengthening foundations and footings and backfilling with coarse textured material help to prevent the structural damage caused by shrinking and swelling and by wetness. Erosion is a hazard on construction sites. It can be controlled by retaining as much of the existing vegetation as possible, by stockpiling topsoil and then using it as the final cover, and by reseeding desirable grasses as soon as possible after construction is complete.

This soil is moderately limited as a site for local roads and streets because of low strength and frost action. Strengthening the base with better suited fill material improves the capacity of the roads and streets to support vehicular traffic. Roadside ditches help to remove excess water and thus minimize the damage caused by frost action.

Because of the wetness and the moderately slow permeability, this soil is severely limited as a site for septic tank absorption fields. Installing subsurface drains around the outer edge of the absorption field helps to remove excess water. Filling or mounding with better suited material improves the capacity of the field to absorb the effluent.

The land capability classification is IIe. The woodland ordination symbol is 5A.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 165,388 acres in the survey area, or more than 99 percent of the total acreage, meets the soil requirements for prime farmland. About 159,000 acres of this prime farmland is used for crops, mainly corn, soybeans, and small grain.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Wayne E. Moore, district conservationist, and John P. VanDenBosch, conservationist agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1978, a total of 138,753 acres in the county was used for crops and pasture (*7*). Of this total, 131,730 acres was used for row crops, mainly corn and soybeans; 3,326 acres for small grain, mainly wheat; and 3,697 acres for rotation hay and pasture.

The potential of the soils in Tipton County for increased food production is good. Applying the latest crop production technology to all of the cropland in the county would increase food production significantly. This soil survey can greatly facilitate the application of such technology.

The paragraphs that follow describe the major management concerns in the areas of the county used for crops and pasture. These concerns are wetness, erosion, fertility, and tilth.

Wetness is the major problem on more than 95 percent of the cropland and pasture in the county. Most areas of the poorly drained Drummer, Patton, and Pella soils are adequately drained. A few areas of these soils in deep depressions, however, cannot be economically drained. Drainage ditches would have to be deep and would have to extend for a great distance to a suitable outlet.

Unless drained, the somewhat poorly drained Crosby and Del Rey soils are so wet that crops are damaged in most years. The wetness can hinder tillage, seed germination, and plant growth. These soils make up 57,598 acres in the county.

Sisson and Strawn soils are naturally well drained, but they tend to dry out slowly after rains. Small areas of wetter soils along drainageways and in swales are commonly included with these soils in mapping, especially where the slope is 2 to 6 percent. A drainage system is needed in some of these included areas.

A combination of subsurface drains and open ditches is the main method of removing excess water in the county. The drains should be more closely spaced in slowly permeable soils than in the more rapidly

permeable soils. In some areas of Drummer, Patton, and Pella soils, deep open ditches and shallow surface drains are adequate outlets for subsurface drains.

Organic soils, such as Palms muck, oxidize and subside when their pore space is filled with air. Therefore, special drainage systems are needed to control the depth and the period of drainage. Keeping the water table at the level required by the crops during the growing season and raising it to the surface during the rest of the year minimize oxidation and subsidence.

Information about the design of drainage systems for each kind of soil is available in local offices of the Soil Conservation Service.

Erosion is the major problem on about 8 percent of the cropland and pasture in the county (*4*). If the slope is more than 2 percent, water erosion is a hazard. Many of the organic soils are susceptible to wind erosion during certain parts of the year.

Loss of the surface layer through erosion is damaging for several reasons. Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. The subsoil in most soils is higher in clay content and lower in organic matter content than the original surface layer. Because of the higher clay content, the plow layer stays wet longer after rains and fieldwork is delayed. In some spots of the more sloping soils, preparing a good seedbed and tilling are difficult because the original friable surface layer has been eroded away. Such spots are common in areas of Sisson, Strawn, Tuscola, and Williamstown soils. In pastured areas the eroded soils are more easily compacted than the uneroded soils. As a result, establishing a stand of grasses and legumes is more difficult. Erosion results in sedimentation in streams. Control of erosion minimizes this pollution and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

Erosion-control measures provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a cover of crop residue and plants on the soil during rainy periods can hold soil losses to an amount that does not reduce the productive capacity of the soils. On livestock farms, where pasture and hay are needed, including forage crops of legumes and grasses in the cropping sequence reduces the susceptibility of the more sloping soils to erosion and provides nitrogen and improves tilth for the following crop.

In Tipton County slopes are so short and irregular that contour farming and terracing are generally impractical. A cropping system that includes hay or pasture plants or conservation tillage helps to control erosion in most areas. A system of conservation tillage that leaves all or part of the crop residue on the surface increases the rate of water infiltration and reduces the runoff rate and the susceptibility to erosion. Ridge-till farming is the most common form of conservation tillage in areas where corn and soybeans are grown. A conservation cropping system that includes grasses and legumes is suited to most of the soils in the county.

Diversions and terraces shorten the length of the slopes and thus are effective in reducing the suceptibility to sheet, rill, and gully erosion. Water- and sediment-control basins are effective in controlling gully erosion. They are most practical on deep, well drained soils that are highly susceptible to erosion. Examples are Sisson and Strawn soils.

Grassed waterways are needed in many areas of the county. They reduce the velocity of runoff and thus increase the rate of water infiltration and help to prevent the formation of gullies. Grassed waterways can be used to stabilize previously eroded areas that have been reshaped and reseeded. Subsurface drains are generally installed below the waterways. They reduce the amount of surface water carried by the waterways.

Many grade stabilization structures are needed in the county because of the large number of open ditches. These structures help to control erosion in areas where runoff drains into an open ditch. Also, they are commonly needed where an excessive gradient results in erosion on the sides and bottom of the ditches.

Fertility is naturally low or medium in most of the upland soils in the county. The neutral or mildly alkaline Sloan soils on flood plains are naturally higher in content of plant nutrients than most of the soils on uplands. The poorly drained Drummer, Patton, and Pella soils are in depressions and receive runoff from the adjacent uplands. They are naturally neutral or slightly acid.

Many upland soils are naturally strongly acid. Applications of ground limestone are needed to raise the pH level sufficiently for good production of alfalfa and other crops that grow well only on nearly neutral soils. Available phosphorus and potash levels are naturally low in most of these soils. On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the needs of the crop, and the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime needed.

Tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous.

The soils in the county have a surface layer of silt loam, loam, silty clay loam, or muck that is moderate to very high in organic matter content. Generally, the structure of these soils is moderate or weak. It allows good infiltration of water into the soils. Conservation tillage, crop residue management, green manure crops, and cover crops help to maintain or improve tilth and increase the organic matter content of these soils.

The dark surface layer of Drummer, Patton, and Pella soils is silty clay loam. Tilling these soils when they are too wet results in the formation of very large clods that

become firm when they dry. As a result of the cloddiness, preparing a good seedbed is difficult.

Field crops suited to the soils and climate of the county include many crops that are not commonly grown. Corn, soybeans, and wheat are the main row crops. Barley, oats, and rye are grown to a limited extent. The grasses and legumes grown in the county include orchardgrass, bromegrass, fescue, timothy, alfalfa, ladino clover, red clover, redtop, and bluegrass.

Specialty crops are of limited commercial importance in the county. Only a small acreage is used for vegetables and small fruit. Deep, well drained or moderately well drained soils that warm up early in spring are especially well suited to many of these crops. Examples are Tuscola soils. Crops can generally be planted and harvested earlier on these soils than on the other soils in the county.

If drained and otherwise well managed, the mucky Palms soils are well suited to a wide variety of vegetable crops and to mint. The well drained and moderately well drained soils in the county are generally suitable for orchards and nursery plants. Soils in low areas where frost is frequent and air drainage is poor generally are poorly suited to early vegetables and fruit.

The latest information about growing specialty crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or

cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

Michael D. Warner, forester, Soil Conservation Service, helped prepare this section.

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil; and *L*, low strength. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, and L.

In table 8, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site

index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced on a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be

required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

James D. McCall, biologist, Soil Conservation Service, helped prepare this section.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, soybeans, wheat, oats, sorghum, sunflowers, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are timothy, orchardgrass, bluegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are goldenrod, beggarweed, wheatgrass, ragweed, pokeweed, sheepsorrel, dock, crabgrass, and dandelion.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, wild cherry, willow, black walnut, apple, hawthorn, dogwood, hickory, hazelnut, blackberry, and elderberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are autumn-olive, silky dogwood, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, spikerush, cattail, waterplantain, arrowhead, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild

herbaceous plants. The wildlife attracted to these areas include bobwhite quail, meadowlark, field sparrow, cottontail rabbit, red fox, and woodchuck.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Edge habitat consists of areas where major land uses or cover types adjoin. A good example is the border between dense woodland and a field of no-till corn. Although not rated in the table, edge habitat is of primary importance to animals from the smallest songbirds to white-tailed deer. Most of the animals that inhabit openland or woodland also frequent edge habitat, and desirable edge areas are consistently used by 10 times as many wildlife as are the centers of large areas of woodland or cropland.

Engineering

Max L. Evans, state conservation engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging,

filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 13 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific

purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by

intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 19.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 4). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

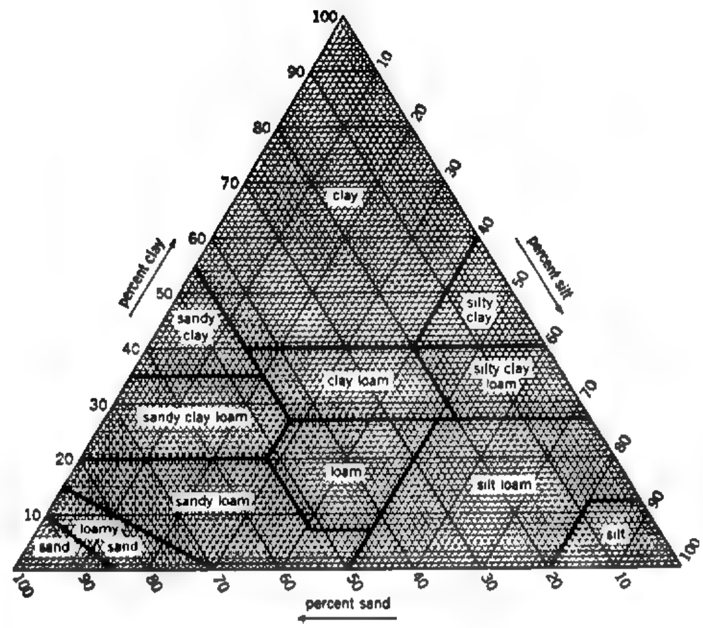

Figure 4.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content

of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 17, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 18 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 18, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 19 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their

Morphology." The soil samples were tested by the State Highway Department of Indiana, Division of Materials and Tests.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*6*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalf (*Ud*, meaning humid, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludalfs (*Hapl*, meaning minimal horizonation, plus *udalf*, the suborder of the Alfisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hapludalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Hapludalfs.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar and nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*5*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*6*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Crosby Series

The Crosby series consists of deep, somewhat poorly drained soils on till plains. These soils formed in a thin mantle of silty material and in the underlying loamy and clayey glacial till. Permeability is slow in the solum and slow and moderately slow in the substratum. Slopes range from 0 to 2 percent.

Crosby soils are similar to Del Rey soils and are adjacent to Del Rey, Drummer, Patton, Pella, Strawn, and Williamstown soils. Del Rey soils are stratified. Drummer, Patton, and Pella soils are along small drainageways and in broad depressional areas. They are

grayer throughout the solum than the Crosby soils. Strawn soils are on the highest part of the landscape. They do not have mottles in the subsoil. Williamstown soils are on the slightly higher rises. They have mottles in the lower part of the subsoil.

Typical pedon of Crosby silt loam, in a cultivated area of Del Rey, sandy substratum-Crosby silt loams, 0 to 2 percent slopes; 265 feet west and 3,300 feet south of the northeast corner of sec. 32, T. 22 N., R. 6 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; common fine roots; common medium and fine pores; medium acid; abrupt smooth boundary.

Bt1—9 to 13 inches; grayish brown (10YR 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; common fine roots; few fine pores; thick patchy dark grayish brown (10YR 4/2) clay films on faces of peds; slightly acid; clear wavy boundary.

2Bt2—13 to 20 inches; grayish brown (10YR 5/2) clay; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; common fine roots; few medium and fine pores; thick discontinuous dark grayish brown (10YR 4/2) clay films on faces of peds; slightly acid; clear wavy boundary.

2Bt3—20 to 35 inches; yellowish brown (10YR 5/4) clay loam; many fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; firm; thick patchy dark grayish brown (10YR 4/2) clay films on faces of peds; neutral; abrupt wavy boundary.

2C—35 to 60 inches; yellowish brown (10YR 5/4) loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; strong effervescence; moderately alkaline.

The solum is typically 24 to 36 inches thick but ranges from 20 to 40 inches. The silty mantle is 8 to 14 inches thick.

The Ap horizon has value of 4 or 5. It is silt loam or loam. It is typically medium acid to neutral but ranges from strongly acid to neutral. In some pedons the uppermost layer is an A horizon, which is very dark grayish brown (10YR 3/2). The Bt horizon has value of 4 or 5 and chroma of 2 to 6. It is clay loam, silty clay loam, silty clay, or clay. The upper part of this horizon is typically medium acid to neutral but ranges from strongly acid to neutral. The lower part is slightly acid or neutral. The C horizon has value of 5 or 6 and chroma of 3 or 4.

Del Rey Series

The Del Rey series consists of deep, somewhat poorly drained soils on till plains. These soils formed in silty and sandy sediments. Permeability is slow in the subsoil and rapid in the substratum. Slopes range from 0 to 2 percent.

Del Rey soils are similar to Crosby soils and are adjacent to Crosby, Drummer, Sisson, Patton, Pella, and Tuscola soils. Crosby soils formed in glacial till. Drummer, Patton, and Pella soils are in broad depressions. Their solum is grayer than that of the Del Rey soils. Sisson and Tuscola soils do not have mottles in the lower part of the subsoil. They are on the higher knolls.

Typical pedon of Del Rey silt loam, sandy substratum, in a cultivated area of Del Rey, sandy substratum-Crosby silt loams, 0 to 2 percent slopes; 2,400 feet east and 1,000 feet north of the southwest corner of sec. 22, T. 21 N., R. 4 E.

Ap—0 to 12 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; many fine roots; many fine pores; neutral; abrupt smooth boundary.

Bt1—12 to 17 inches; brown (10YR 5/3) silty clay loam; many medium distinct light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; firm; few fine roots; few fine pores; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; neutral; clear wavy boundary.

Bt2—17 to 23 inches; brown (10YR 5/3) silty clay loam; many coarse distinct light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; firm; few fine roots; few fine pores; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; thin dark grayish brown (10YR 4/2) worm casts inside peds; neutral; clear wavy boundary.

Bt3—23 to 35 inches; grayish brown (10YR 5/2) silty clay loam; many coarse distinct light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; few fine roots; few medium and fine pores; thin discontinuous dark grayish brown (10YR 4/2) clay films on faces of peds; dark grayish brown (10YR 4/2) worm casts inside peds; neutral; clear wavy boundary.

2C—35 to 55 inches; brown (10YR 5/3) silty clay loam that has strata of silt loam; massive; friable; strong effervescence; moderately alkaline; abrupt wavy boundary.

3C—55 to 60 inches; brown (10YR 5/3) loamy fine sand that has thin strata of silt loam; massive; friable; strong effervescence; moderately alkaline.

The solum is 24 to 48 inches thick. The content of gravel is 0 to 5 percent throughout the solum. It increases with increasing depth.

The Ap horizon has chroma of 1 or 2. It is loam or silt loam. Some pedons have an AB horizon, but plowing

commonly has mixed this horizon with the Ap horizon. The Bt horizon has value of 4 to 6 and chroma of 2 to 6. It is medium acid to neutral in the upper part and slightly acid to moderately alkaline in the lower part.

Drummer Series

The Drummer series consists of deep, poorly drained soils in depressions on till plains and lake plains. These soils formed in silty water-laid material and in the underlying loamy glacial till. Permeability is moderate in the subsoil and moderately slow in the substratum. Slopes range from 0 to 2 percent.

Drummer soils are similar to Pella soils and are adjacent to Crosby, Del Rey, Palms, and Pella soils. Pella soils are stratified throughout. Crosby and Del Rey soils have a surface layer that is lighter colored than that of the Drummer soils. They are on the slightly higher rises. Palms soils formed in organic material 16 to 30 inches deep over silty or sandy sediments. They are on the lower parts of the landscape.

Typical pedon of Drummer silty clay loam, till substratum, in a cultivated area of Pella, sandy substratum-Drummer, till substratum, silty clay loams; 2,200 feet west and 2,200 feet north of the southeast corner of sec. 4, T. 21 N., R. 3 E.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate coarse granular structure; friable; many fine and very fine roots; few fine pores; neutral; abrupt smooth boundary.

AB—10 to 13 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; common medium distinct dark gray (10YR 4/1) and yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; firm; many fine and very fine roots; few medium pores; neutral; clear wavy boundary.

Bg1—13 to 20 inches; gray (10YR 5/1) silty clay loam; common medium distinct yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; weak fine and medium prismatic structure parting to moderate coarse angular blocky; firm; many fine and very fine roots; common fine pores; black (10YR 2/1) krotovinas, 1 to 4 inches in diameter and 1 to 3 inches apart, extending vertically through the horizon; neutral; clear wavy boundary.

Bg2—20 to 31 inches; gray (10YR 6/1) silty clay loam; many medium distinct dark yellowish brown (10YR 4/6) and gray (10YR 5/1) mottles; weak coarse prismatic structure parting to moderate coarse angular blocky; firm; few fine and very fine roots; common fine pores; black (10YR 2/1) krotovinas, 1 to 4 inches in diameter and 1 to 3 inches apart, extending vertically through the horizon; neutral; clear wavy boundary.

Bg3—31 to 43 inches; gray (10YR 5/1) silty clay loam; common medium distinct yellowish brown (10YR 5/6) and dark gray (10YR 4/1) mottles; weak fine prismatic structure parting to moderate medium subangular blocky; firm; neutral; clear wavy boundary.

2BCg—43 to 50 inches; gray (10YR 5/1), stratified silty clay loam and loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to weak fine angular blocky; firm; few faint light brownish gray (10YR 6/2) silt coatings on faces of peds; few pebbles; slight effervescence; mildly alkaline; clear wavy boundary.

3C—50 to 60 inches; mottled gray (10YR 5/1) and yellowish brown (10YR 5/6) loam; massive; firm; about 5 percent gravel; strong effervescence; moderately alkaline.

The solum is 40 to 70 inches thick. The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The Bg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is slightly acid or neutral. The 2BCg horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 or 2. It is neutral or mildly alkaline.

Palms Series

The Palms series consists of deep, very poorly drained soils on lake plains. These soils formed in organic deposits overlying silty and sandy sediments. Permeability is moderately slow to moderately rapid in the organic material and moderately slow or moderate in the silty or sandy material. Slopes range from 0 to 2 percent.

Palms soils are adjacent to Drummer, Patton, and Pella soils. The adjacent soils are mineral throughout. They are on the slightly higher rises and in depressions.

Typical pedon of Palms muck, drained, in a cultivated field; 1,600 feet west and 1,000 feet north of the southeast corner of sec. 8, T. 22 N., R. 3 E.

Op—0 to 14 inches; sapric material, black (7.5YR 2/1) broken face and rubbed; about 3 percent fiber, 1 percent rubbed; moderate medium granular structure; very friable; many fine roots; neutral; abrupt smooth boundary.

Oa—14 to 24 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 2 percent fiber, none rubbed; moderate medium granular structure; very friable; many medium and fine roots; neutral; clear wavy boundary.

Cg1—24 to 42 inches; gray (10YR 5/1) silt loam; common medium distinct grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) mottles; massive; friable; few fine roots; neutral; clear wavy boundary.

Cg2—42 to 60 inches; gray (N 5/0) silt loam that has thin strata of sandy loam; common medium distinct

dark gray (10YR 4/1) and yellowish brown (10YR 5/4) mottles; massive; friable; strong effervescence; mildly alkaline.

The organic material is 16 to 30 inches thick. It is typically medium acid to neutral but ranges from strongly acid to mildly alkaline. In some pedons it has woody fragments 1 to 4 inches in diameter.

The surface tier has hue of 5YR, 7.5YR, or 10YR. In some pedons the mineral content in this tier is as much as 10 percent. The subsurface and bottom tiers have hue of 5YR, 7.5YR, or 10YR or are neutral in hue. They have value of 2 or 3 and chroma of 0 to 2. The fiber content in these tiers is less than 10 percent after rubbing. In some pedons the mineral content is as much as 20 percent. The C horizon has hue of 2.5Y or 10YR or is neutral in hue. It has value of 4 to 6 and chroma of 0 to 3. It typically is neutral or mildly alkaline but ranges from slightly acid to moderately alkaline.

Patton Series

The Patton series consists of deep, poorly drained soils in upland depressions and on lake plains and till plains. These soils formed in silty water-laid sediments. Permeability is moderate or moderately slow in the subsoil and moderate in the substratum. Slopes range from 0 to 2 percent.

Patton soils are adjacent to Crosby, Del Rey, and Palms soils. Crosby and Del Rey soils have a surface layer that is lighter colored than that of the Patton soils. They are on the slightly higher rises. Palms soils formed in organic material 16 to 30 inches deep over silty and sandy sediments. They are on the lower parts of the landscape.

Typical pedon of Patton silty clay loam, sandy substratum, in a cultivated field; 2,450 feet west and 2,500 feet south of the northeast corner of sec. 29, T. 22 N., R. 5 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; few fine and very fine roots; common fine and medium pores; neutral; clear smooth boundary.

AB—9 to 12 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate medium angular blocky structure parting to moderate fine granular; few fine and medium roots; common fine and medium pores; friable; neutral; gradual smooth boundary.

Bg1—12 to 25 inches; gray (10YR 5/1) silty clay loam; many coarse distinct dark gray (10YR 4/1) and yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; few medium and fine roots; few medium and fine pores; neutral; clear wavy boundary.

Bg2—25 to 42 inches; gray (10YR 5/1) silty clay loam; many coarse distinct yellowish brown (10YR 5/6) and brown (7.5YR 4/3) mottles; moderate coarse prismatic structure parting to moderate medium subangular blocky; firm; common fine roots; many fine and very fine pores; dark gray (10YR 4/1) worm casts; distinct tubular tongues of very dark gray (10YR 3/1) silty clay loam 1 to 3 inches in diameter and 12 to 18 inches apart extend vertically through the horizon; neutral; clear wavy boundary.

Bg3—42 to 55 inches; mottled gray (10YR 5/1) and yellowish brown (10YR 5/6) silty clay loam that has strata of silt loam; moderate coarse prismatic structure parting to weak medium subangular blocky; firm; few medium and fine roots; many medium and fine pores; distinct tubular tongues of dark gray (10YR 4/1) silty clay loam 1 to 3 inches in diameter and 12 to 18 inches apart extend vertically through the horizon; neutral; clear wavy boundary.

Cg—55 to 60 inches; light olive brown (2.5Y 5/4) silt loam that has thin strata of sandy loam and loamy sand; common medium distinct gray (10YR 5/1) mottles; massive; firm; strong effervescence; moderately alkaline.

The solum is 45 to 60 inches thick. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silt loam or silty clay loam. The Bg horizon has value of 4 to 6 and chroma of 1 to 6. The mottles in this horizon have hue of 10YR, 2.5Y, or 7.5YR, value of 4 to 6, and chroma of 1 to 8.

Pella Series

The Pella series consists of deep, poorly drained, moderately permeable soils in depressions on till plains and lake plains. These soils formed in silty material over stratified sediments. Slopes range from 0 to 2 percent.

Pella soils are similar to Drummer soils and are adjacent to Crosby, Del Rey, Drummer, and Palms soils. Drummer soils have a substratum of till. Crosby and Del Rey soils have a surface layer that is lighter colored than that of the Pella soils. They are on the slightly higher rises. Palms soils formed in organic material 16 to 30 inches deep over silty and sandy sediments. They are on the lower parts of the landscape.

Typical pedon of Pella silty clay loam, sandy substratum, in a cultivated area of Pella, sandy substratum-Drummer, till substratum, silty clay loams; 1,000 feet east and 800 feet south of the northwest corner of sec. 26, T. 22 N., R. 5 E.

Ap—0 to 11 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; many fine and very fine roots; few fine pores; neutral; abrupt smooth boundary.

A—11 to 14 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; many fine and very fine roots; few medium pores; neutral; clear smooth boundary.

Bg—14 to 18 inches; grayish brown (10YR 5/2) silty clay loam; many medium distinct dark yellowish brown (10YR 4/4) mottles; weak fine and medium prismatic structure; firm; many fine and very fine roots; common fine pores; thin discontinuous black (10YR 2/1) organic stains on faces of peds; neutral; clear wavy boundary.

BCg—18 to 28 inches; grayish brown (10YR 5/2) silty clay loam; common medium distinct dark yellowish brown (10YR 4/6) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; firm; few fine roots; common fine pores; slight effervescence; mildly alkaline; clear wavy boundary.

Cg—28 to 40 inches; light brownish gray (10YR 6/2) silt loam; many medium distinct dark yellowish brown (10YR 4/6) mottles; massive; firm; strong effervescence; moderately alkaline; clear wavy boundary.

2Cg1—40 to 50 inches; grayish brown (10YR 5/2) silt loam that has thin strata of loamy sand; many medium distinct dark yellowish brown (10YR 4/6) mottles; massive; firm; strong effervescence; moderately alkaline; clear wavy boundary.

2Cg2—50 to 60 inches; grayish brown (10YR 5/2) silt loam that has thin strata of loamy sand and sand; massive; firm; strong effervescence; moderately alkaline.

The solum is 24 to 40 inches thick. The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The Bg horizon has value of 4 to 6 and chroma of 1 or 2. It is silty clay loam or clay loam.

Sisson Series

The Sisson series consists of deep, well drained, moderately permeable soils on till plains and lake plains. These soils formed in stratified, silty or loamy sediments overlying sandy outwash. Slopes range from 6 to 12 percent.

Sisson soils are similar to Strawn soils and are adjacent to Del Rey, Sloan, Strawn, and Tuscola soils. Strawn soils formed in glacial till. Del Rey soils have grayish mottles in the upper part of the subsoil. They are on the less sloping parts of the landscape. Sloan soils are grayer throughout than the Sisson soils. They are on flood plains. Tuscola soils are in the lower positions on the landscape. They have mottles in the lower part of the subsoil. Their solum is 40 to 60 inches thick.

Typical pedon of Sisson loam, in a cultivated area of Sisson-Strawn complex, 6 to 12 percent slopes, eroded; 1,280 feet west and 1,700 feet north of the southeast corner of sec. 31, T. 21 N., R. 4 E.

Ap—0 to 7 inches; dark yellowish brown (10YR 4/4) loam, yellowish brown (10YR 5/4) dry; about 15 percent brown (7.5YR 4/4) clay loam from the subsoil; weak fine granular structure; friable; many fine and very fine roots; few fine pores; slightly acid; abrupt smooth boundary.

Bt1—7 to 19 inches; brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; many medium and very fine roots; few fine pores; thick continuous brown (10YR 4/3) clay films on faces of peds; slightly acid; clear wavy boundary.

Bt2—19 to 29 inches; dark brown (7.5YR 3/4) clay loam; moderate medium subangular blocky structure; firm; many fine and very fine roots; many fine pores; thick continuous dark yellowish brown (10YR 3/4) clay films on faces of peds; slightly acid; clear wavy boundary.

Bt3—29 to 35 inches; dark brown (7.5YR 3/4) clay loam; moderate medium subangular blocky structure; firm; many very fine roots; many fine and very fine pores; thin discontinuous dark brown (7.5YR 3/3) clay films on faces of peds; neutral; clear wavy boundary.

C1—35 to 52 inches; yellowish brown (10YR 5/4), stratified silt loam and sandy loam; massive; friable; slight effervescence; mildly alkaline; abrupt wavy boundary.

C2—52 to 60 inches; yellowish brown (10YR 5/4), stratified sand and loamy sand; single grain; loose; strong effervescence; moderately alkaline.

The solum is 24 to 40 inches thick. The content of gravel is 0 to 1 percent in the upper part of the profile and 0 to 5 percent in the lower part.

The Ap horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. In some pedons the uppermost layer is an A horizon. This horizon is loam or silt loam 2 to 4 inches thick. It has chroma of 1 or 2. The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is clay loam, loam, or sandy clay loam. It is slightly acid to moderately alkaline. The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4.

Sloan Series

The Sloan series consists of deep, very poorly drained soils on flood plains. These soils formed in alluvium. Permeability is moderately slow or moderate in the upper part of the profile and rapid in the lower part of the substratum. Slopes range from 0 to 2 percent.

Sloan soils are adjacent to Sisson and Strawn soils. The adjacent soils are on uplands. Their solum is browner than that of the Sloan soils.

Typical pedon of Sloan silt loam, sandy substratum, occasionally flooded, in a pasture; 1,650 feet east and 264 feet south of the northwest corner of sec. 30, T. 21 N., R. 5 E.

Ap—0 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many fine roots; neutral; abrupt smooth boundary.

AB—12 to 22 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; firm; common fine roots; many medium and few fine pores; neutral; clear smooth boundary.

Bg—22 to 30 inches; dark gray (10YR 4/1) silty clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; firm; common fine roots; many medium and fine pores; neutral; gradual wavy boundary.

Cg1—30 to 45 inches; dark gray (10YR 4/1) clay loam; many medium distinct dark yellowish brown (10YR 4/6) mottles; massive; firm; common fine roots; many medium pores; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg2—45 to 60 inches; dark gray (10YR 4/1) fine sand that has thin strata of silt loam and silty clay loam; many medium distinct dark yellowish brown (10YR 4/6) mottles; massive; firm; few fine pores; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. Reaction is slightly acid to mildly alkaline in the upper part of the profile and neutral to moderately alkaline in the lower part. The depth to calcareous material ranges from about 22 to 40 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silt loam or silty clay loam. The Bg and Cg horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. The Bg horizon is silty clay loam, clay loam, silt loam, or loam. The upper part of the Cg horizon is silty clay loam or clay loam, and the lower part is stratified sandy loam, fine sand, or loam.

Strawn Series

The Strawn series consists of deep, well drained soils on till plains. These soils formed in loamy glacial till. Permeability is moderate in the solum and moderately slow in the substratum. Slopes range from 2 to 12 percent.

Strawn soils are similar to Sisson soils and are adjacent to Crosby, Sisson, Sloan, Tuscola, and Williamstown soils. Sisson soils formed in stratified sediments. Crosby, Tuscola, and Williamstown soils are in the slightly lower, less sloping areas. Crosby soils have a clayey subsoil and have mottles throughout. Tuscola soils have less clay and more sand in the lower part than the Strawn soils. Williamstown soils have mottles in the lower part of the subsoil. Sloan soils are grayer throughout than the Strawn soils. They are on flood plains.

Typical pedon of Strawn loam, in a cultivated area of Tuscola, till substratum-Strawn complex, 1 to 6 percent slopes, eroded; 2,700 feet west and 100 feet south of the northeast corner of sec. 31, T. 21 N., R. 4 E.

Ap—0 to 8 inches; brown (10YR 4/3) loam, yellowish brown (10YR 5/4) dry; weak fine granular structure; friable; many fine and very fine roots; many fine and medium pores; mixed with some dark yellowish brown (10YR 4/4) clay loam; slightly acid; abrupt smooth boundary.

Bt—8 to 18 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; few fine and very fine roots; many medium and fine pores; thick continuous dark brown (10YR 3/3) clay films on faces of peds; neutral; clear wavy boundary.

C—18 to 60 inches; yellowish brown (10YR 5/4) loam; massive; very firm; few fine roots; many medium and fine pores; strong effervescence; moderately alkaline.

The solum is 10 to 22 inches thick. The Ap horizon has value of 4 or 5 and chroma of 2 or 3. It is slightly acid or neutral. In some pedons the uppermost layer is an A horizon, which is very dark grayish brown (10YR 3/2). The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam or silty clay loam. It is medium acid to mildly alkaline. The C horizon has chroma of 3 or 4.

Tuscola Series

The Tuscola series consists of deep, moderately well drained soils on till plains and lake plains. These soils formed in stratified silty, loamy, and sandy sediments overlying loamy glacial till. Permeability is moderate in the subsoil and moderately slow in the substratum. Slopes range from 1 to 6 percent.

The Tuscola soils in this county are taxadjuncts to the series because they do not have grayish mottles in the upper 10 inches of the argillic horizon. Also, they are slightly browner in the C horizon than is definitive for the series. These differences, however, do not alter the usefulness or behavior of the soils.

Tuscola soils are adjacent to Del Rey, Sisson, and Strawn soils. Del Rey soils have grayish mottles in the upper part of the subsoil. They are on the less sloping parts of the landscape. Sisson soils have no mottles in the subsoil. They are in the higher landscape positions. Strawn soils have more clay and less sand in the subsoil than the Tuscola soils and have a thinner solum. Also, they are slightly higher on the landscape.

Typical pedon of Tuscola silt loam, till substratum, in a cultivated area of Tuscola, till substratum-Strawn complex, 1 to 6 percent slopes, eroded; 1,500 feet west and 200 feet south of the northeast corner of sec. 31, T. 21 N., R. 4 E.

Ap—0 to 8 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak medium granular structure; friable; many fine and very fine roots; few fine pores; slightly acid; abrupt smooth boundary.

BE—8 to 15 inches; brown (10YR 5/3) loam; weak fine subangular blocky structure; friable; many fine and very fine roots; few fine pores; slightly acid; clear wavy boundary.

Bt1—15 to 27 inches; brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; many fine and very fine roots; many fine pores; thin continuous dark yellowish brown (10YR 4/4) clay films on faces of peds; medium acid; clear wavy boundary.

Bt2—27 to 32 inches; brown (7.5YR 5/4) clay loam; common medium distinct light brownish gray (10YR 6/2) and yellowish brown (10YR 5/8) mottles; moderate medium and coarse subangular blocky structure; firm; many very fine roots; many medium and fine pores; thin discontinuous brown (7.5YR 4/4) clay films on faces of peds; slightly acid; clear wavy boundary.

Bt3—32 to 43 inches; brown (7.5YR 4/4) sandy loam; many coarse prominent pinkish gray (5YR 6/2) mottles; weak coarse subangular blocky structure; firm; few fine roots; many fine pores; thick patchy brown (7.5YR 5/4) clay films on faces of peds; slightly acid; clear smooth boundary.

C1—43 to 50 inches; dark yellowish brown (10YR 4/4) loamy sand; common medium prominent pinkish gray (5YR 6/2) and yellowish red (5YR 5/6) mottles; single grain; loose; brown (7.5YR 4/4) clay bridges between sand grains; neutral; clear wavy boundary.

C2—50 to 54 inches; yellowish brown (10YR 5/4), stratified very fine sand and silt loam; few fine distinct yellowish brown (10YR 5/8) mottles; single grain and massive; loose and friable; strong effervescence; moderately alkaline; clear wavy boundary.

2C—54 to 60 inches; yellowish brown (10YR 5/4) loam; many medium distinct yellowish brown (10YR 5/8) and light gray (10YR 7/2) mottles; massive; strong effervescence; moderately alkaline.

The solum is 40 to 60 inches thick. The content of gravel ranges from 0 to 10 percent in the lower part of the profile.

The Ap horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. In some pedons the uppermost layer is an A horizon. This horizon is loam or silt loam 2 to 4 inches thick. It has hue of 10YR, value of 3, and chroma of 1 or 2. The Bt horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam, loam, or sandy clay loam. It is medium acid or slightly acid in the upper part and slightly acid or neutral in the lower part. The C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6.

Williamstown Series

The Williamstown series consists of deep, moderately well drained soils on till plains. These soils formed in a thin mantle of silty material and in the underlying glacial till. Permeability is moderate in the solum and moderately slow in the substratum. Slopes range from 1 to 4 percent.

Williamstown soils are adjacent to Crosby, Del Rey, and Strawn soils. Crosby and Del Rey soils contain more clay throughout the solum than the Williamstown soils and are grayer or have grayish mottles below the surface layer. They are in the slightly lower landscape positions. Strawn soils have no mottles in the subsoil. They are in the slightly higher landscape positions.

Typical pedon of Williamstown silt loam, 1 to 4 percent slopes, in a cultivated field; 100 feet east and 1,200 feet south of the northwest corner of sec. 33, T. 21 N., R. 5 E.

Ap—0 to 7 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; friable; many fine and very fine roots; many very fine pores; slightly acid; abrupt smooth boundary.

E—7 to 16 inches; brown (10YR 4/3) silt loam; common fine distinct yellowish brown (10YR 5/4) mottles; weak medium platy structure; firm; many fine and very fine roots; many very fine pores; slightly acid; clear wavy boundary.

2Bt1—16 to 24 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; many fine and very fine roots; few medium and fine pores; thin continuous dark brown (10YR 4/3) clay films on faces of peds; neutral; clear wavy boundary.

2Bt2—24 to 32 inches; brown (10YR 4/3) clay loam; common medium distinct light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; few fine and very fine roots; few fine and very fine pores; thin continuous dark brown (10YR 4/3) clay films on faces of peds; neutral; clear wavy boundary.

2BC—32 to 37 inches; yellowish brown (10YR 5/4) loam; common medium distinct light brownish gray (10YR 6/2) mottles; weak thick platy structure parting to moderate fine subangular blocky; firm; few fine roots; few medium and fine pores; few patchy dark brown (10YR 4/3) clay films on faces of peds; slight effervescence; mildly alkaline; clear wavy boundary.

2C—37 to 60 inches; yellowish brown (10YR 5/4) loam; massive; very firm; common fine distinct gray (10YR 6/1) mottles; about 3 percent gravel; violent effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. The silty mantle is 8 to 18 inches thick.

The Ap horizon has value of 4 or 5 and chroma of 2 or 3. In some pedons the uppermost layer is an A horizon. This horizon is 1 to 3 inches thick. It has hue of 10YR, value of 3, and chroma of 1 or 2. The Bt horizon has value of 4 or 5 and chroma of 3 to 6. It is silty clay loam or clay loam.

Formation of the Soils

This section relates the major factors of soil formation to the soils in the county. It also describes the processes of soil formation.

Factors of Soil Formation

Soils form through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material accumulated and has existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil. Some time is always required for the differentiation of soil horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effects of any one factor unless conditions are specified for the other four.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineralogical composition of the soil. The parent materials in Tipton County were deposited by glaciers or by meltwater from the glaciers. Some of these materials were reworked and redeposited by the subsequent actions of water and wind. The last glacier covered the county about 12,000 to 15,000 years ago. Although most parent materials are of common glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited. The parent materials in Tipton County are glacial till, outwash deposits, lacustrine deposits, alluvium, and organic material.

Glacial till is material laid down directly by glaciers with a minimum of water action. It consists of particles of different sizes. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water. The loamy glacial till in Tipton County is calcareous and firm. Soils that formed in glacial till typically are loam or clay loam and have well developed structure. An example is Strawn soils.

Outwash material was deposited by running water from melting glaciers. The size of the particles that make up outwash varies according to the velocity of the water that carried the material. When the water slowed down, the coarser particles were deposited first. The finer particles, such as very fine sand, silt, and clay, remained in suspension in the more slowly moving water. Outwash deposits generally occur as layers of similar-size particles, such as loam, sandy loam, sand, gravel, and other coarse particles. Sisson soils are an example of soils that formed in outwash deposits.

Lacustrine material was deposited by still, or ponded, glacial meltwater. Because the coarser fragments dropped out of moving water as outwash, only the finer particles, such as very fine sand, silt, and clay, remained to settle out in still water. Lacustrine deposits generally are silty but have thin lenses of sandy material. The soils in Tipton County that formed in lacustrine deposits typically are silty clay loam. Drummer, Patton, and Pella soils are examples.

Alluvium was recently deposited by floodwater along present streams. This material varies in texture, depending on the velocity of the water from which it was deposited. Sloan soils formed in alluvium.

Organic material is made up of partially decomposed plant remains. After the glaciers withdrew from the survey area, water was left standing in lakes and in depressions on outwash plains, till plains, and old lake plains. Grasses and sedges growing in these shallow lakes died, and their remains settled to the bottom. Because of wetness, the plant remains did not decompose. Later, northern white-cedar and other water-tolerant trees grew in the areas. As these trees died, their remains became a part of the organic accumulation. The lakes were eventually filled with organic material, which developed into peat. The plant remains subsequently decomposed into muck. In some areas the material has changed very little since deposition. Palms

soils formed in organic material 16 to 30 inches deep over silty and sandy material.

Plant and Animal Life

Plants have been the principal organisms influencing the soils in Tipton County. Bacteria, fungi, and earthworms also have affected soil formation. The chief contribution of plant and animal life to soil formation is the addition of organic matter and nitrogen to the soil. The kind of organic material on and in the soil depends on the kind of plants that have grown on the soil. The remains of these plants accumulated on the surface, decayed, and eventually became humus. The roots of plants provided channels for the downward movement of water through the soil and added organic matter and plant nutrients as they decayed.

The native vegetation in Tipton County was mainly deciduous trees. Differences in natural soil drainage and minor variations in the kind of parent material affected the composition of the forest species. In general, the well drained upland soils, such as Strawn soils, supported sugar maple, beech, red oak, shagbark hickory, and black walnut. The somewhat poorly drained soils, such as Crosby soils, supported red oak, elm, green ash, bur oak, and pin oak. The wet soils primarily supported silver maple, black ash, sycamore, yellow-poplar, and American basswood. In a few wet areas, sphagnum and other mosses contributed substantially to the accumulation of organic matter. Patton soils formed under wet conditions.

In the prairie areas many islandlike groves of white oak and post oak grew on the slightly elevated knolls and numerous patches of small timber grew on the higher parts of the landscape. The wide flats and all of the depressions were either marshes or ponds most of the year. Drummer and Pella soils formed under prairie vegetation.

Climate

Climate helps to determine the kind of plant and animal life on and in the soil, the amount of water available for the weathering of minerals and the translocation of soil material, and the rate of chemical reactions in the soil. These influences are important, but they affect the soils throughout a large area rather than in a relatively small area, such as a county.

The climate in Tipton County is cool and humid. It is presumably similar to the climate under which the soils formed. The climate is fairly uniform throughout the county. Only minor differences among the soils are the result of differences in climate.

Relief

Relief has markedly affected the soils in Tipton County through its effect on the water table, erosion, plant cover, and soil temperature. Slopes range from 0 to 12 percent. Runoff is most rapid on the steeper slopes. Water is temporarily ponded in low areas.

Natural soil drainage in the county ranges from well drained on ridgetops to very poorly drained in depressions. Through its effect on soil aeration, drainage determines the color of the soil. Water and air move freely through well drained soils but slowly through poorly drained soils. In Strawn and other well drained, well aerated soils, the iron compounds that give most soils their color are oxidized and are brownish or reddish. Patton and other poorly drained, poorly aerated soils are dull gray and mottled.

Time

Generally, a long time is required for the development of distinct soil horizons. Differences in the length of time that the parent material has been in place are commonly reflected in the degree of profile development. Some soils form rapidly. Others form slowly.

The soils in the county range from young to mature. The glacial deposits in which many of the soils in the county formed have been exposed to the soil-forming processes long enough for the development of distinct horizons. Some soils have not been in place long enough for distinct horizons to develop. Sloan soils, which formed in alluvial material, are an example.

Processes of Soil Formation

Several processes have been involved in the formation of the soils in Tipton County. These processes are the accumulation of organic matter; the dissolution, transfer, and removal of calcium carbonates and bases; the liberation and translocation of silicate clay minerals; and the reduction and transfer of iron. In most soils more than one of these processes have helped to differentiate horizons.

Some organic matter has accumulated in the surface layer of all the soils in the county. The content of organic matter is low in some soils but is high in others. Generally, the soils that have the highest content of organic matter, such as Drummer, Patton, and Pella soils, have a thick, dark surface soil.

Carbonates and bases have been leached from the upper horizons of nearly all the soils in the county. Leaching probably preceded the translocation of silicate clay minerals. Most of the carbonates and some of the bases have been leached from the A and B horizons of well drained soils. Even in the wettest soils, some leaching is indicated by the absence of carbonates and by an acid reaction. Leaching is slow in wet soils because of a high water table or the slow movement of water through the profile.

Silicate clays accumulate in pores and on the faces of the structural units along which water moves. The leaching of bases and the translocation of silicate clays are among the more important processes of horizon

differentiation in the county. Strawn soils are an example of soils in which translocated silicate clays in the form of clay films have accumulated in the Bt horizon.

Gleying, or the reduction and transfer of iron, has occurred in all of the very poorly drained to somewhat poorly drained soils in the county. This process has significantly affected horizon differentiation in these soils. It is evidenced by a grayish color in the subsoil. Reduction is commonly accompanied by some transfer of the iron, either from upper horizons to lower ones or completely out of the profile. Mottles, which are in some horizons, indicate the segregation of iron.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, subsurface. Removal of excess ground water through buried drains installed within the soil profile. The drains collect the water and convey it to a gravity or pump outlet.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when

light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They

have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow..less than 0.06 inch

Slow	0 06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0 6 inch to 2.0 inches
Moderately rapid	2.0 to 6 0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-75 at Frankfort, Indiana)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	33.9	16.6	25.3	61	-14	9	2.03	0.93	2.91	5	5.5
February----	37.6	19.7	28.7	63	-11	13	2.09	1.13	2.86	5	6.7
March-------	47.2	27.8	37.5	77	3	112	2.78	1.52	3.81	7	4.1
April-------	61.3	39.3	50.3	83	20	316	4.03	2.28	5.45	9	.5
May---------	72.1	49.5	60.8	91	29	645	4.19	2.82	5.44	8	.0
June--------	81.7	58.8	70.3	96	41	909	4.28	2.28	5.91	7	.0
July--------	84.7	62.1	73.4	97	46	1,035	4.56	2.58	6.17	7	.0
August------	83.0	59.7	71.4	94	43	973	3.38	1.67	4.78	5	.0
September---	76.7	52.6	64.7	93	33	741	3.22	1.22	4.82	5	.0
October-----	66.1	41.9	54.0	86	22	441	2.69	1.26	3.85	5	.0
November----	49.6	31.2	40.5	75	10	101	2.91	1.75	3.94	6	1.9
December----	37.8	21.8	29.8	65	-10	39	2.80	1.07	4.18	7	6.3
Year------	61.0	40.1	50.6	98	-15	5,334	38.96	34.38	43.40	76	25.0

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-75 at Frankfort, Indiana)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 21	May 1	May 17
2 years in 10 later than--	Apr. 17	Apr. 26	May 11
5 years in 10 later than--	Apr. 8	Apr. 16	Apr. 30
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 16	Oct. 6	Sept. 24
2 years in 10 earlier than--	Oct. 21	Oct. 10	Sept. 29
5 years in 10 earlier than--	Oct. 30	Oct. 19	Oct. 9

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-75 at Frankfort, Indiana)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	184	166	139
8 years in 10	190	173	146
5 years in 10	203	185	161
2 years in 10	216	198	176
1 year in 10	223	205	183

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
DeA	Del Rey, sandy substratum-Crosby silt loams, 0 to 2 percent slopes	57,598	34.5
Pa	Palms muck, drained	256	0.2
Pc	Palms muck, undrained	292	0.2
Pn	Patton silty clay loam, sandy substratum	77,540	46.5
Ps	Pella, sandy substratum-Drummer, till substratum, silty clay loams	15,758	9.4
SaC2	Sisson-Strawn complex, 6 to 12 percent slopes, eroded	451	0.3
Sh	Sloan silt loam, sandy substratum, occasionally flooded	1,971	1.2
TuB2	Tuscola, till substratum-Strawn complex, 1 to 6 percent slopes, eroded	6,788	4.1
Ud	Udorthents, loamy	208	0.1
WkB	Williamstown silt loam, 1 to 4 percent slopes	5,733	3.4
	Water area less than 40 acres in size	87	0.1
	Total	166,682	100.0

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
DeA	Del Rey, sandy substratum-Crosby silt loams, 0 to 2 percent slopes (where drained)
Pn	Patton silty clay loam, sandy substratum (where drained)
Ps	Pella, sandy substratum-Drummer, till substratum, silty clay loams (where drained)
Sh	Sloan silt loam, sandy substratum, occasionally flooded (where drained)
TuB2	Tuscola, till substratum-Strawn complex, 1 to 6 percent slopes, eroded
WkB	Williamstown silt loam, 1 to 4 percent slopes

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Winter wheat	Orchardgrass-alfalfa hay*	Tall fescue
		Bu	Bu	Bu	Tons	AUM**
DeA: Del Rey-Crosby	IIw	107	37	47	4.1	8.2
Pa: Palms	IIIw	105	42	---	---	---
Pc: Palms	Vw	---	---	---	---	---
Pn: Patton	IIw	140	45	52	5.2	10.4
Ps: Pella-Drummer	IIw	146	50	58	5.1	10.2
SaC2: Sisson-Strawn	IIIe	101	31	49	3.8	7.6
Sh: Sloan	IIIw	120	42	45	4.6	9.2
TuB2: Tuscola-Strawn	IIe	108	35	42	3.7	7.4
Ud***. Udorthents						
WkB: Williamstown	IIe	115	43	46	4.1	7.8

* The Drummer, Patton, Pella, and Sloan soils are suitable for alfalfa only if they are drained.

** Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

*** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--CAPABILITY CLASSES AND SUBCLASSES

(Udorthents, loamy, are excluded. Absence of an entry indicates no acreage)

Class	Total acreage	Major management concerns (Subclass)			
		Erosion (e)	Wetness (w)	Soil problem (s)	Climate (c)
		Acres	Acres	Acres	Acres
I	---	---	---	---	---
II	163,417	12,521	150,896	---	---
III	2,678	451	2,227	---	---
IV	---	---	---	---	---
V	292	---	292	---	---
VI	---	---	---	---	---
VII	---	---	---	---	---
VIII	---	---	---	---	---

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Volume*	Trees to plant
DeA**:									
Del Rey	4C	Slight	Slight	Severe	Severe	Northern red oak	70	52	White oak, northern red oak, yellow-poplar, eastern white pine, silver maple.
						White oak	70	52	
						Bur oak	---	---	
						Red maple	---	---	
Crosby	4A	Slight	Slight	Slight	Slight	White oak	75	57	Eastern white pine, northern red oak, white ash, red maple, yellow-poplar, American sycamore.
						Pin oak	85	67	
						Yellow-poplar	85	81	
						Northern red oak	75	57	
Pa, Pc Palms	2W	Slight	Severe	Severe	Severe	White ash	51	35	
						Red maple	51	33	
						Quaking aspen	56	56	
						Black willow	---	---	
						Silver maple	76	30	
Pn Patton	5W	Slight	Severe	Severe	Severe	Pin oak	85	67	White ash, Norway spruce, red maple, eastern white pine.
						White oak	75	57	
						Northern red oak	75	57	
SaC2**:									
Sisson	4A	Slight	Slight	Slight	Slight	Northern red oak	75	57	Eastern white pine, black walnut, yellow-poplar, white ash, red pine, northern red oak, white oak.
						Black walnut	---	---	
						White oak	---	---	
						Yellow-poplar	---	---	
						Black cherry	---	---	
						Sugar maple	---	---	
						White ash	---	---	
Strawn	4A	Slight	Slight	Slight	Slight	White oak	80	62	White oak, black walnut, northern red oak, green ash, eastern white pine, red pine, sugar maple.
						Northern red oak	80	62	
						Yellow-poplar	90	90	
						Black walnut	---	---	

See footnotes at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
Sh: Sloan	5W	Slight	Severe	Severe	Severe	Pin oak	86	68	Pin oak, American sycamore, eastern cottonwood, red maple, green ash, swamp white oak, silver maple.
						Green ash	---	---	
						Red maple	---	---	
						Swamp white oak	---	---	
						Eastern cottonwood	---	---	
TuB2**: Tuscola	5A	Slight	Slight	Slight	Slight	White oak	90	72	Eastern white pine, white ash, yellow-poplar, black walnut.
						Northern red oak	90	72	
						Yellow-poplar	98	104	
Strawn	4A	Slight	Slight	Slight	Slight	White oak	80	62	White oak, black walnut, northern red oak, green ash, eastern white pine, red pine, sugar maple.
						Northern red oak	80	62	
						Yellow-poplar	90	90	
						Black walnut	---	---	
WkB: Williamstown	5A	Slight	Slight	Slight	Slight	White oak	85	67	Black walnut, white oak, yellow-poplar.
						Yellow-poplar	100	107	
						White ash	85	88	

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
DeA*:					
Del Rey	---	Eastern redcedar, Amur privet, arrowwood, American cranberrybush, Amur honeysuckle, Washington hawthorn.	Austrian pine, green ash, osageorange.	Pin oak, eastern white pine.	---
Crosby	---	Arrowwood, eastern redcedar, Washington hawthorn, Amur honeysuckle, American cranberrybush, Amur privet, Tatarian honeysuckle.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
Pa Palms	Common ninebark, whitebelle honeysuckle.	Amur honeysuckle, Amur privet, silky dogwood, nannyberry viburnum, Tatarian honeysuckle.	Tall purple willow	Golden willow, black willow.	Imperial Carolina poplar.
Pc. Palms					
Pn Patton	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern white-cedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
Ps*:					
Pella	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern white-cedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.

See footnote at end of table.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
Ps*: Drummer	---	Amur honeysuckle, American cranberrybush, Amur privet, silky dogwood.	Austrian pine, white fir, northern white-cedar, Washington hawthorn, Norway spruce, blue spruce.	Eastern white pine	Pin oak.
SaC2*: Sisson	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.
Strawn	---	Amur privet, silky dogwood, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.
Sh: Sloan	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	Northern white-cedar, Norway spruce, Austrian pine, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
TuB2*: Tuscola	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.
Strawn	---	Amur privet, silky dogwood, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.
Ud*. Udorthents					
WkB: Williamstown	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
DeA*:					
Del Rey	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Crosby	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Pa, Pc Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
Pn Patton	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Ps*:					
Pella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Drummer	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
SaC2*:					
Sisson	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Strawn	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
Sh Sloan	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
TuB2*:					
Tuscola	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
Strawn	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
Ud*. Udorthents					
WkB Williamstown	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
DeA*:										
Del Rey	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Crosby	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Pa, Pc Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
Pn Patton	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
Ps*:										
Pella	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Drummer	Fair	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
SaC2*:										
Sisson	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Strawn	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Sh Sloan	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
TuB2*:										
Tuscola	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Strawn	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Ud*. Udorthents										
WkB Williamstown	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
DeA*:						
Del Rey	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Crosby	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Pa, Pc Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
Pn Patton	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
Ps*:						
Pella	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
Drummer	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
SaC2*:						
Sisson	Severe: cutbanks cave.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Strawn	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Sh Sloan	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
TuB2*:						
Tuscola	Severe: cutbanks cave, wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength.	Slight.
Strawn	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Ud*. Udorthents						
WkB--------------- Williamstown	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "poor," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
DeA*:					
Del Rey	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Crosby	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Pa, Pc: Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
Pn: Patton	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
Ps*:					
Pella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
Drummer	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
SaC2*:					
Sisson	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Poor: thin layer.
Strawn	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, small stones, slope.
Sh: Sloan	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
TuB2*:					
Tuscola	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Strawn	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey, small stones.
Ud*. Udorthents					
WkB: Williamstown	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
DeA*:				
Del Rey	Fair: wetness.	Probable	Improbable: too sandy.	Poor: thin layer.
Crosby	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Pa, Pc Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
Pn Patton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Ps*:				
Pella	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Drummer	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
SaC2*:				
Sisson	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.
Strawn	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Sh Sloan	Poor: wetness.	Probable	Probable	Poor: area reclaim, wetness.
TuB2*:				
Tuscola	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Strawn	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Ud*. Udorthents				
WkB Williamstown	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Aquifer-fed excavated ponds	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
DeA*:						
Del Rey	Severe: seepage.	Severe: slow refill, cutbanks cave.	Percs slowly, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Crosby	Slight	Severe: no water.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily, rooting depth.
Pa, Pc Palms	Severe: seepage.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
Pn Patton	Moderate: seepage.	Severe: slow refill, cutbanks cave.	Ponding, frost action.	Ponding	Erodes easily, ponding.	Wetness, erodes easily.
Ps*:						
Pella	Moderate: seepage.	Severe: cutbanks cave.	Ponding, frost action, cutbanks cave.	Ponding	Ponding, too sandy.	Wetness.
Drummer	Moderate: seepage.	Severe: slow refill.	Ponding, frost action.	Ponding	Ponding	Wetness.
SaC2*:						
Sisson	Severe: slope.	Severe: no water.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Strawn	Severe: slope.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Sh Sloan	Severe: seepage.	Severe: slow refill, cutbanks cave.	Flooding, frost action.	Wetness, erodes easily, flooding.	Erodes easily, wetness.	Wetness, erodes easily.
TuB2*:						
Tuscola	Moderate: seepage, slope.	Severe: slow refill, cutbanks cave.	Slope	Slope, wetness, erodes easily.	Erodes easily, wetness.	Erodes easily.
Strawn	Moderate: slope.	Severe: no water.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
Ud*. Udorthents						
WkB Williamstown	Moderate: seepage.	Severe: no water.	Frost action	Wetness, erodes easily.	Erodes easily, wetness.	Erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
DeA*:											
Del Rey	0-12	Silt loam	ML, CL-ML	A-4	0	95-100	95-100	85-95	60-90	20-36	2-10
	12-55	Silty clay loam, silty clay.	CH, CL	A-6, A-7	0	95-100	95-100	90-100	60-95	35-55	15-30
	55-60	Stratified fine sand to loamy sand.	SM, SW-SM, SP-SM	A-1, A-3, A-2	0	95-100	90-100	45-75	5-30	---	NP
Crosby	0-9	Silt loam	CL, CL-ML, ML	A-4, A-6	0	100	95-100	80-100	50-90	15-30	4-15
	9-35	Clay loam, silty clay loam, clay.	CL	A-6, A-7	0-3	90-100	85-100	75-95	65-95	35-50	15-25
	35-60	Loam	CL, ML, CL-ML	A-4, A-6	0-3	85-100	80-95	75-90	50-75	15-35	4-15
Pa Palms	0-24	Sapric material	PT	---	---	---	---	---	---	---	---
	24-60	Clay loam, silty clay loam, silt loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
Pc Palms	0-18	Sapric material	PT	---	---	---	---	---	---	---	---
	18-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
Pn Patton	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-100	30-40	10-20
	12-55	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-100	30-45	10-25
	55-60	Stratified loamy sand to clay loam.	ML, CL, SM, SC	A-4, A-6, A-2-4, A-2-6	0	100	95-100	60-100	20-85	<35	NP-15
Ps*:											
Pella	0-14	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-25
	14-18	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-25
	18-40	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	85-95	25-40	10-20
	40-60	Stratified silt loam to sand.	SM, SC, ML, CL	A-4, A-6	0	85-100	80-100	45-100	35-85	<30	2-12
Drummer	0-13	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	30-50	15-30
	13-43	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	30-50	15-30
	43-50	Stratified silty clay loam to loam.	CL	A-6	0	100	95-100	75-95	50-85	25-40	10-20
	50-60	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-100	75-95	55-80	20-30	6-15
SaC2*:											
Sisson	0-7	Loam	CL, CL-ML	A-4, A-6	0	100	100	85-95	60-85	<30	5-15
	7-35	Loam, clay loam, silt loam.	CL	A-4, A-6	0	100	100	85-100	60-90	18-40	7-25
	35-60	Stratified silt loam to fine sand.	CL, ML, SM, SC	A-2, A-4, A-6	0	100	95-100	65-95	25-90	<35	NP-15

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
SaC2*:											
Strawn----------	0-7	Clay loam--------	CL	A-6, A-7	0-5	90-100	80-100	75-95	50-95	25-45	10-23
	7-18	Silty clay loam, clay loam.	CL	A-6, A-7	0-5	90-100	80-100	75-95	50-95	25-45	10-23
	18-60	Loam, silt loam, clay loam.	CL, SC	A-4, A-6	0-5	75-100	70-100	60-95	40-95	20-35	7-18
Sh--------------- Sloan	0-12	Silt loam--------	CL, CL-ML	A-4, A-6	0	90-100	85-95	75-95	55-85	20-35	5-15
	12-45	Loam, silty clay loam, clay loam.	CL	A-6, A-7	0	85-95	80-95	65-95	50-85	30-50	10-30
	45-60	Stratified coarse sand to silty clay loam.	SP, SP-SM	A-1, A-3, A-2	0-5	55-90	50-90	20-60	3-10	---	NP
TuB2*:											
Tuscola---------	0-8	Silt loam--------	ML, CL-ML, CL	A-4	0	100	100	90-100	70-90	<30	3-10
	8-32	Loam, clay loam	CL	A-6	0	100	100	85-100	60-80	25-40	10-20
	32-43	Sandy loam-------	SM-SC, SC	A-2-4, A-4	0	100	100	60-70	30-40	20-30	5-10
	43-54	Stratified very fine sand to silt loam.	CL-ML, ML, SM, SM-SC	A-4	0	98-100	95-100	75-90	35-70	<20	NP-5
	54-60	Loam-------------	CL, ML, CL-ML	A-4	0-2	90-100	85-100	70-95	50-75	<25	3-8
Strawn----------	0-8	Loam-------------	CL, ML, CL-ML	A-4, A-6	0	95-100	95-100	90-100	90-100	20-40	3-20
	8-18	Silty clay loam, clay loam.	CL	A-6, A-7	0-5	90-100	80-100	75-95	50-95	25-45	10-23
	18-60	Loam, silt loam, clay loam.	CL, SC	A-4, A-6	0-5	75-100	70-100	60-95	40-95	20-35	7-18
Ud*. Udorthents											
WkB-------------- Williamstown	0-16	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	90-100	70-90	20-35	4-15
	16-32	Clay loam, silty clay loam.	CL	A-6	0	100	95-100	85-100	70-95	30-40	10-20
	32-37	Loam-------------	CL, CL-ML	A-6, A-4	0	100	95-100	80-95	60-80	20-35	5-15
	37-60	Loam-------------	ML, CL-ML, CL	A-4, A-6	0-2	100	95-100	80-95	55-75	20-35	3-11

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
DeA*:											
Del Rey----------	0-12	20-30	1.30-1.50	0.6-2.0	0.20-0.24	5.1-7.3	Low----------	0.43	3	5	1-3
	12-55	30-45	1.35-1.55	0.06-0.2	0.11-0.18	5.6-8.4	Moderate-----	0.43			
	55-60	3-10	1.50-1.70	6.0-20	0.05-0.09	7.4-8.4	Low----------	0.15			
Crosby----------	0-9	11-24	1.35-1.45	0.6-2.0	0.20-0.24	5.1-7.3	Low----------	0.43	3	5	1-3
	9-35	35-45	1.50-1.70	0.06-0.2	0.15-0.20	5.1-7.3	Moderate-----	0.43			
	35-60	15-27	1.70-2.00	0.06-0.6	0.05-0.17	7.4-8.4	Low----------	0.43			
Pa---------------- Palms	0-24	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	-------------	----	2	3	>75
	24-60	7-30	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	----			
Pc---------------- Palms	0-18	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	-------------	----	2	3	>75
	18-60	7-30	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	----			
Pn---------------- Patton	0-12	27-35	1.15-1.35	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	7	4-6
	12-55	27-35	1.25-1.45	0.2-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43			
	55-60	3-30	1.20-1.50	0.6-2.0	0.06-0.14	7.4-8.4	Low----------	0.28			
Ps*:											
Pella------------	0-14	27-40	1.35-1.50	0.6-2.0	0.21-0.23	6.1-7.8	Moderate-----	0.28	5	6	3-6
	14-18	24-40	1.40-1.60	0.6-2.0	0.18-0.22	6.6-7.8	Moderate-----	0.28			
	18-40	15-30	1.35-1.60	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.28			
	40-60	7-24	1.50-1.75	0.6-2.0	0.06-0.20	7.4-8.4	Low----------	0.28			
Drummer----------	0-13	27-35	1.40-1.60	0.6-2.0	0.21-0.23	6.1-7.3	Moderate-----	0.28	5	7	4-6
	13-43	27-35	1.40-1.60	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.28			
	43-50	22-30	1.45-1.65	0.6-2.0	0.17-0.22	6.6-7.8	Moderate-----	0.28			
	50-60	15-27	1.70-1.80	0.2-0.6	0.05-0.12	7.9-8.4	Low----------	0.28			
SaC2*:											
Sisson-----------	0-7	10-20	1.30-1.65	0.6-2.0	0.20-0.24	6.1-7.3	Low----------	0.32	5	5	.5-1
	7-35	18-35	1.30-1.65	0.6-2.0	0.15-0.22	6.1-8.4	Moderate-----	0.43			
	35-60	5-24	1.30-1.65	0.6-2.0	0.05-0.22	7.4-8.4	Low----------	0.43			
Strawn----------	0-7	27-30	1.35-1.55	0.6-2.0	0.15-0.20	5.6-7.3	Moderate-----	0.37	3	7	.5-1
	7-18	27-35	1.35-1.55	0.6-2.0	0.15-0.20	6.1-7.8	Moderate-----	0.37			
	18-60	20-30	1.50-1.70	0.2-0.6	0.08-0.12	7.4-8.4	Low----------	0.37			
Sh---------------- Sloan	0-12	15-27	1.20-1.40	0.6-2.0	0.20-0.24	6.1-7.8	Low----------	0.37	5	6	3-6
	12-45	20-35	1.25-1.55	0.2-2.0	0.17-0.20	6.1-8.4	Moderate-----	0.37			
	45-60	0-30	1.20-1.50	6.0-20	0.02-0.05	6.6-8.4	Low----------	0.10			
TuB2*:											
Tuscola----------	0-8	10-25	1.30-1.40	0.6-2.0	0.22-0.24	5.6-6.5	Low----------	0.37	3	5	1-2
	8-32	25-35	1.40-1.60	0.6-2.0	0.15-0.19	5.6-6.5	Moderate-----	0.37			
	32-43	15-25	1.40-1.60	0.6-2.0	0.12-0.14	5.6-7.3	Low----------	0.24			
	43-54	5-23	1.45-1.60	0.6-2.0	0.19-0.21	6.6-8.4	Low----------	0.37			
	54-60	12-20	1.70-1.90	0.2-0.6	0.05-0.10	7.4-8.4	Low----------	0.37			
Strawn----------	0-8	18-27	1.15-1.45	0.6-2.0	0.20-0.24	6.1-7.3	Low----------	0.37	4	6	1-3
	8-18	27-35	1.35-1.55	0.6-2.0	0.15-0.20	5.6-7.8	Moderate-----	0.37			
	18-60	22-30	1.50-1.70	0.2-0.6	0.08-0.12	7.4-8.4	Low----------	0.37			
Ud*. Udorthents											

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
WkB---------------Williamstown	0-16	14-26	1.30-1.45	0.6-2.0	0.22-0.24	5.6-7.3	Low-----------	0.37	5	5	1-3
	16-32	27-35	1.35-1.50	0.6-2.0	0.15-0.21	5.6-7.3	Moderate------	0.37			
	32-37	18-27	1.35-1.50	0.6-2.0	0.15-0.19	6.1-7.8	Low-----------	0.37			
	37-60	16-26	1.45-1.70	0.2-0.6	0.05-0.19	7.4-8.4	Low-----------	0.37			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "occasional," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
DeA*:										
Del Rey	C	None	---	---	1.0-2.5	Apparent	Jan-May	High	High	Low.
Crosby	C	None	---	---	1.0-3.0	Perched	Jan-Apr	High	High	Moderate.
Pa, Pc Palms	A/D	None	---	---	+1-1.0	Apparent	Nov-May	High	High	Moderate.
Pn Patton	B/D	None	---	---	+.5-2.0	Apparent	Mar-Jun	High	High	Low.
Ps*:										
Pella	B/D	None	---	---	+.5-1.0	Apparent	Oct-Jun	High	High	Low.
Drummer	B/D	None	---	---	+.5-2.0	Apparent	Mar-Jun	High	High	Moderate.
SaC2*:										
Sisson	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Strawn	B	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
Sh Sloan	B/D	Occasional	Brief	Nov-Jun	0-1.0	Apparent	Nov-Jun	High	High	Low.
TuB2*:										
Tuscola	B	None	---	---	2.0-4.0	Apparent	Feb-Jun	Moderate	Moderate	Moderate.
Strawn	B	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
Ud*. Udorthents										
WkB Williamstown	C	None	---	---	1.5-3.5	Perched	Jan-Apr	High	Moderate	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 19.--ENGINEERING INDEX TEST DATA

(Dashes indicate that data were not available. MAX means maximum dry density; OPT, optimum moisture; LL, liquid plasticity index; UN, Unified; and NP, nonplastic)

Soil name and location	Parent material	Report number S82-IN-159	Depth	Moisture density		Percentage passing sieve--				Percentage smaller than--				LL
				MAX	OPT	No. 4	No. 10	No. 40	No. 200	0.05 mm	0.02 mm	0.005 mm	0.002 mm	
			In	Lb/cf	Pct									Pct
Crosby silt loam: 265 feet west and 3,300 feet south of the northeast corner of sec. 32, T. 22 N., R. 6 E.	Thin layer of silty material over loamy glacial till.	22-1	0-9	105	18	100	100	98	84	---	---	---	18	NP
		22-3	13-20	107	21	100	99	99	93	---	---	---	35	49
		22-5	35-48	120	13	98	98	94	68	---	---	---	18	27
		22-6	48-60	111	17	99	99	97	80	---	---	---	27	39
Del Rey silt loam, sandy substratum: 2,400 feet east and 1,000 feet north of the southwest corner of sec. 22, T. 21 N., R. 4 E.	Silty and clayey sediments.	19-1	0-12	107	17	100	99	99	90	---	---	---	14	NP
		19-3	17-23	107	19	100	99	99	94	---	---	---	28	42
		19-6	35-45	120	12	100	98	99	45	---	---	---	13	NP
		19-7	45-55	114	15	96	94	90	58	---	---	---	22	31
Patton silty clay loam, sandy substratum: 2,110 feet west and 1,590 feet south of the northeast corner of sec. 32, T. 22 N., R. 5 E.	Silty sediments.	16-1	0-12	92	27	100	100	99	97	---	---	---	29	45
		16-2	12-25	104	20	100	100	99	98	---	---	---	32	46
		16-7	42-50	114	16	100	99	98	95	---	---	---	15	29
		16-8	50-60	113	16	99	99	97	87	---	---	---	21	37
Pella silty clay loam, sandy substratum: 400 feet west and 2,400 feet north of the southeast corner of sec. 4, T. 21 N., R. 3 E.	Silty material over loamy sediments.	20-1	0-10	97	23	100	99	99	96	---	---	---	30	41
		20-3	15-22	103	21	99	99	99	97	---	---	---	32	45
		20-8	46-55	114	16	99	98	97	89	---	---	---	20	31
		20-9	55-60	108	17	100	100	100	99	---	---	---	26	37

TABLE 20.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Crosby	Fine, mixed, mesic Aeric Ochraqualfs
Del Rey	Fine, illitic, mesic Aeric Ochraqualfs
Drummer	Fine-silty, mixed, mesic Typic Haplaquolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Patton	Fine-silty, mixed, mesic Typic Haplaquolls
Pella	Fine-silty, mixed, mesic Typic Haplaquolls
Sisson	Fine-loamy, mixed, mesic Typic Hapludalfs
Sloan	Fine-loamy, mixed, mesic Fluvaquentic Haplaquolls
Strawn	Fine-loamy, mixed, mesic Typic Hapludalfs
*Tuscola	Fine-loamy, mixed, mesic Aquic Hapludalfs
Udorthents	Loamy, mixed, mesic Typic Udorthents
Williamstown	Fine-loamy, mixed, mesic Aquic Hapludalfs

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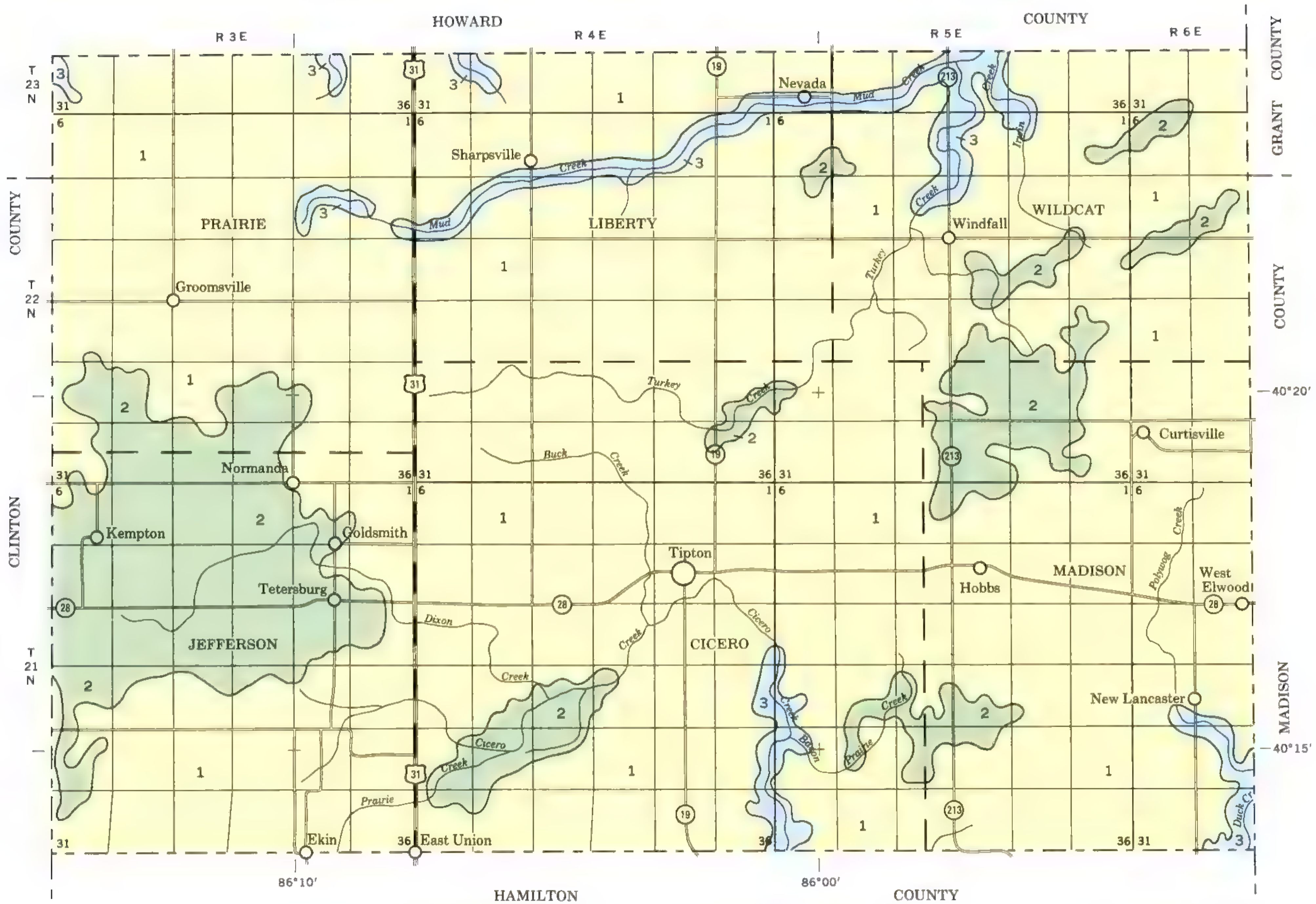


LEGEND

1	PATTON-DEL REY-CROSBY association: Nearly level, poorly drained and somewhat poorly drained soils that formed in silty sediments, in silty and sandy sediments, or in a thin mantle of silty material and the underlying loamy and clayey glacial till; on lake plains and till plains
2	PELLA-PATTON-DRUMMER association: Nearly level, poorly drained soils that formed in silty sediments or in silty sediments and the underlying loamy glacial till; on lake plains and till plains
3	SLOAN-TUSCOLA-STRAWN association: Nearly level to moderately sloping, very poorly drained, moderately well drained, and well drained soils that formed in alluvium, in stratified silty, loamy, and sandy sediments over loamy glacial till, or in loamy glacial till; on flood plains, lake plains, and till plains

COMPILED 1986

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION
INDIANA DEPARTMENT OF NATURAL RESOURCES
SOIL AND WATER CONSERVATION COMMITTEE

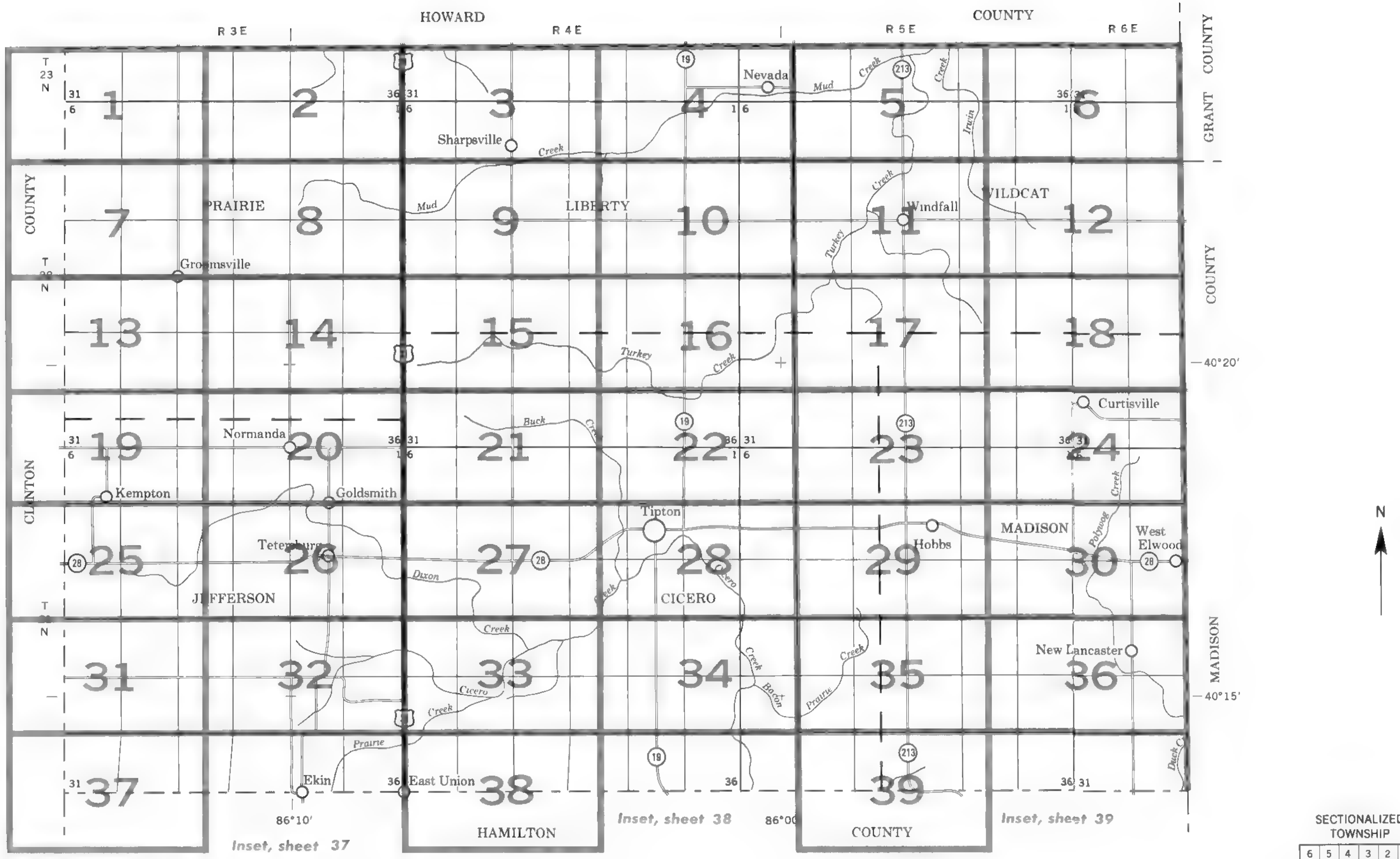
GENERAL SOIL MAP

TIPTON COUNTY, INDIANA

Scale 1:126,720

1 0 1 2 3 4 Miles

1 0 3 6 Km



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

IND

TIP

SOIL LEGEND

Map symbols consist of a combination of letters or of letters and a number. The first capital letter is the initial one of the map unit name. The lowercase letter that follows separates map units having names that begin with the same letter, except that it does not separate sloping or eroded phases. The second capital letter indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 indicates that the soil is eroded.

SYMBOL	NAME
DeA	Del Rey, sandy substratum-Crosby silt loams, 0 to 2 percent slopes
Pa	Palms muck, drained
Pc	Palms muck, undrained
Pn	Patton silty clay loam, sandy substratum
Ps	Pella, sandy substratum-Drummer, till substratum, silty clay loams
SaC2	Sisson-Strawn complex, 6 to 12 percent slopes, eroded
Sh	Sloan silt loam, sandy substratum, occasionally flooded
TuB2	Tuscola, till substratum-Strawn complex, 1 to 6 percent slopes, eroded
Ud	Udorthents, loamy
WkB	Williamstown silt loam, 1 to 4 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label) — Swift Airport

- Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small — water, w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water, w
- Intermittent — int, i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — DeA SaC2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

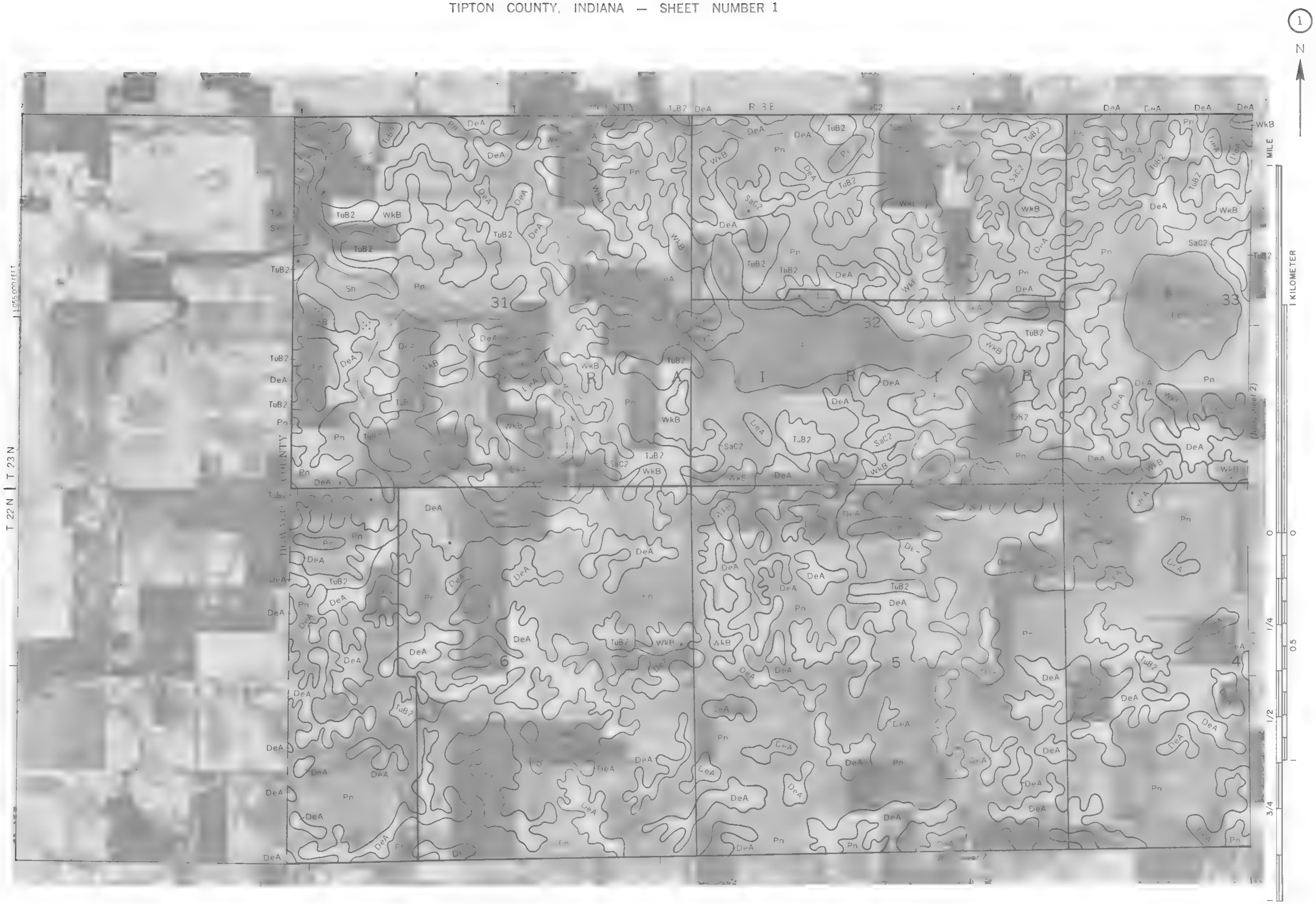
GULLY

DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

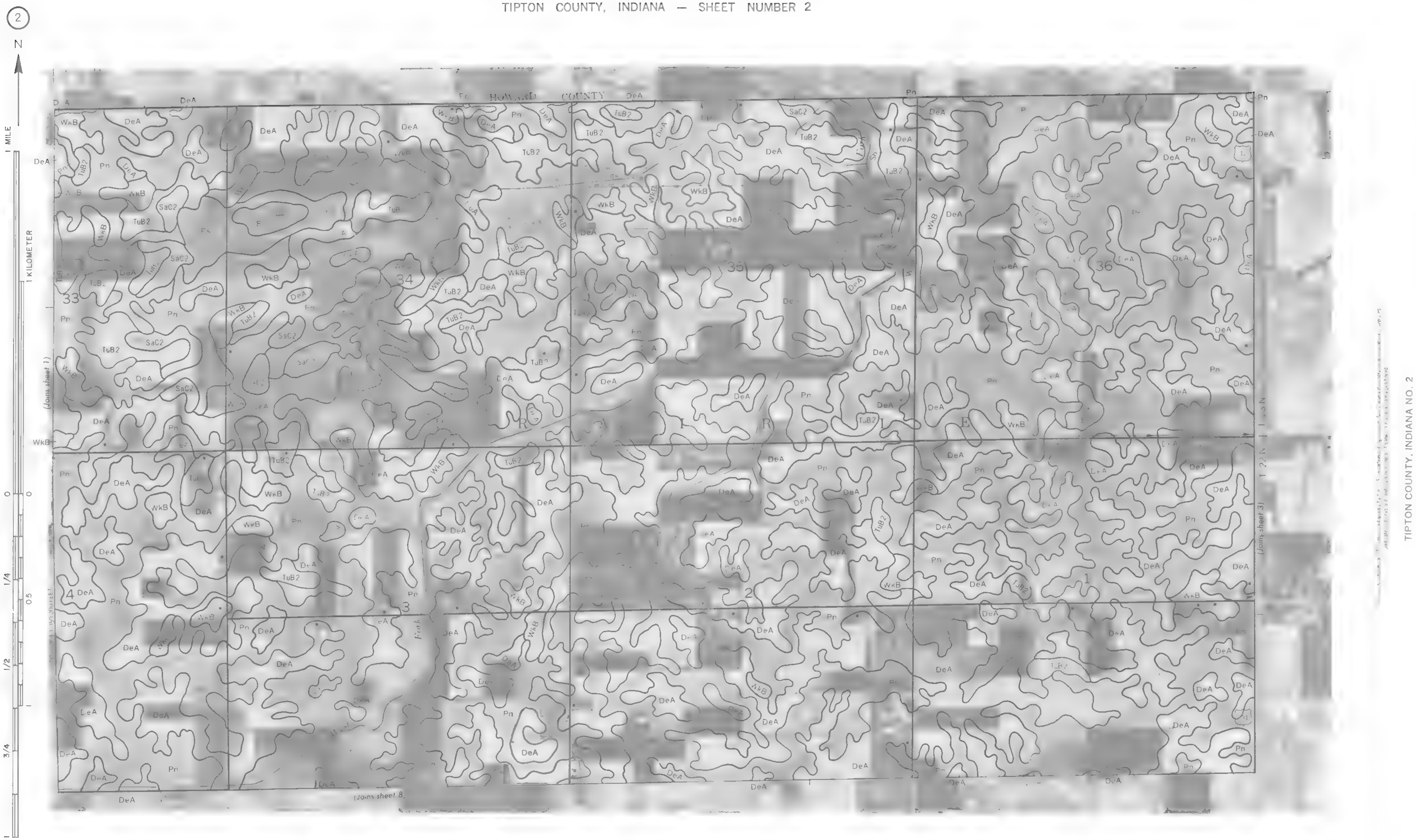
MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Sanitary landfill up to 5 acres in size

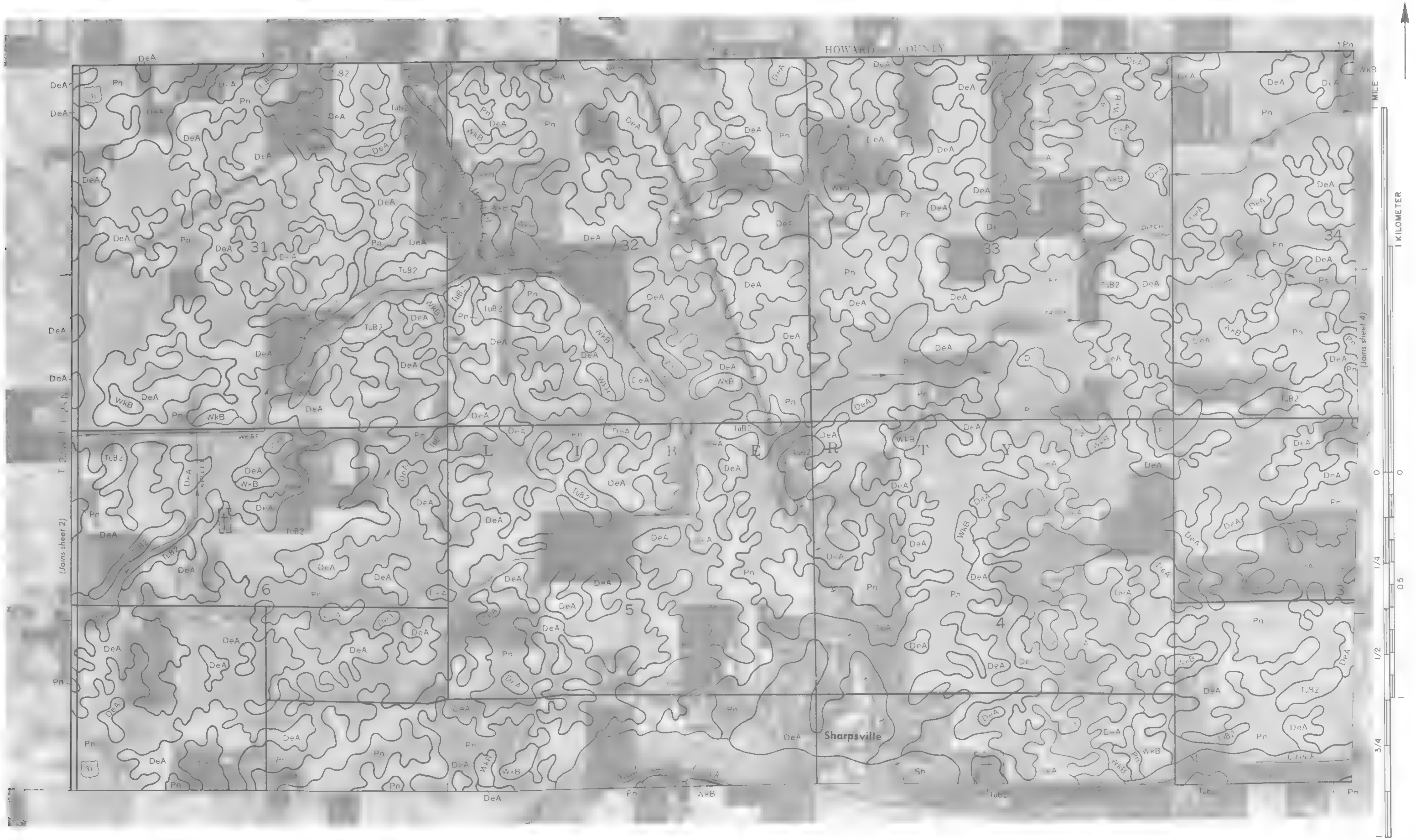


TIPTON COUNTY, INDIANA NO. 1

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

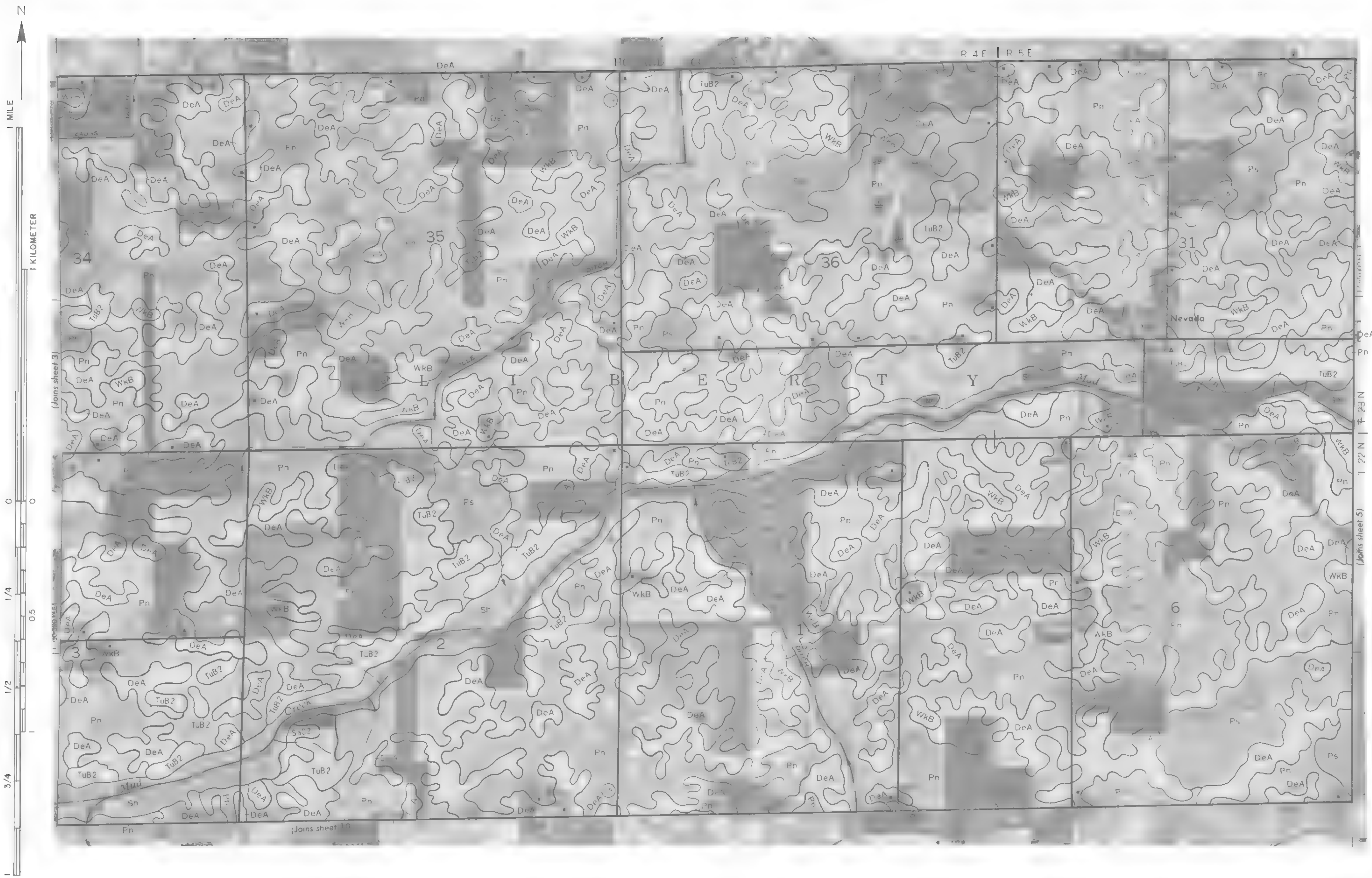

2
N
1 MILE
1 KILOMETER
HOWARD COUNTY
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 8)
33
34
35
36
4
3
2
1
TIPTON COUNTY, INDIANA NO. 2

3



TIPTON COUNTY, INDIANA NO. 3

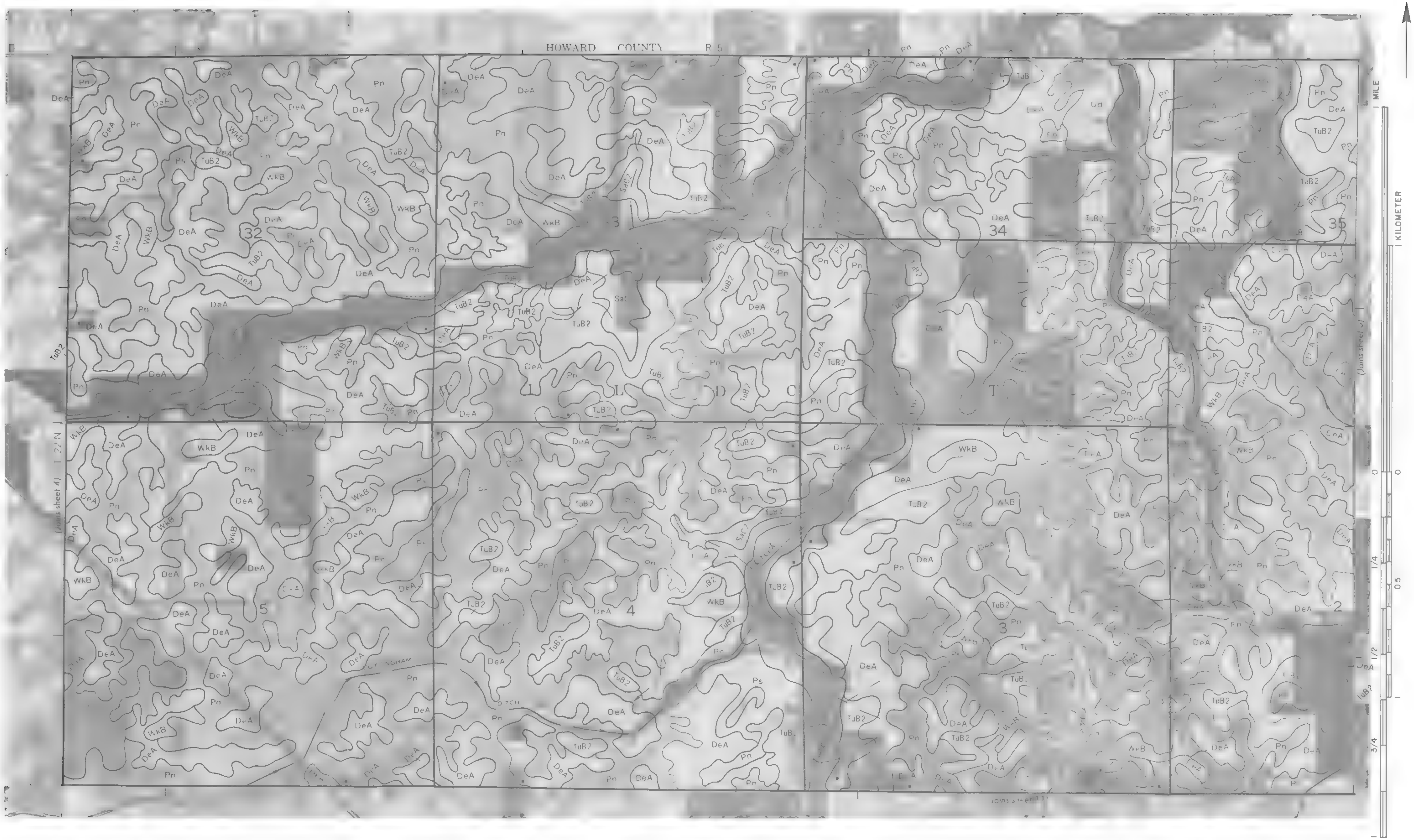
4



TIPTON COUNTY, INDIANA NO. 4

5

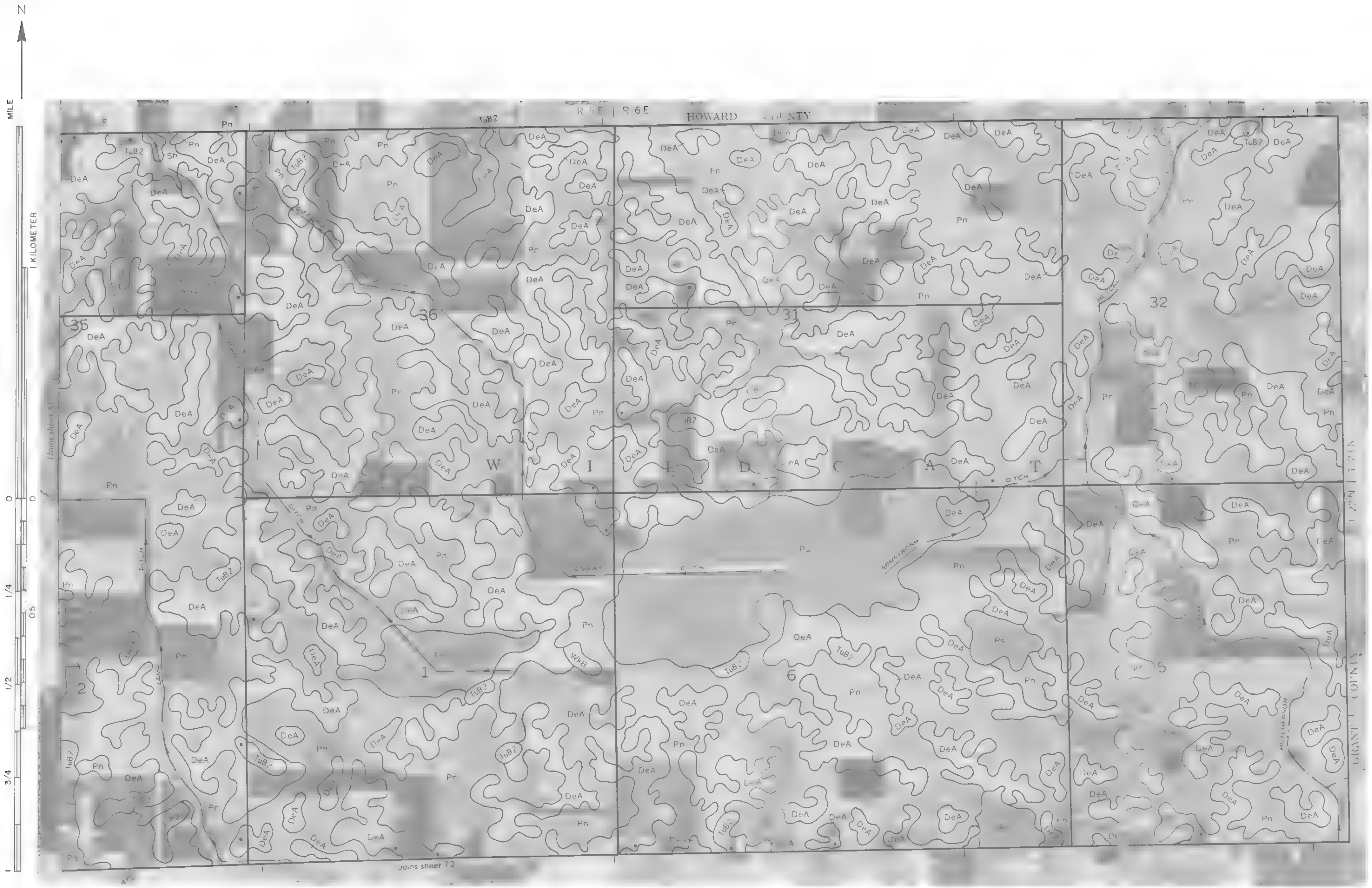
N

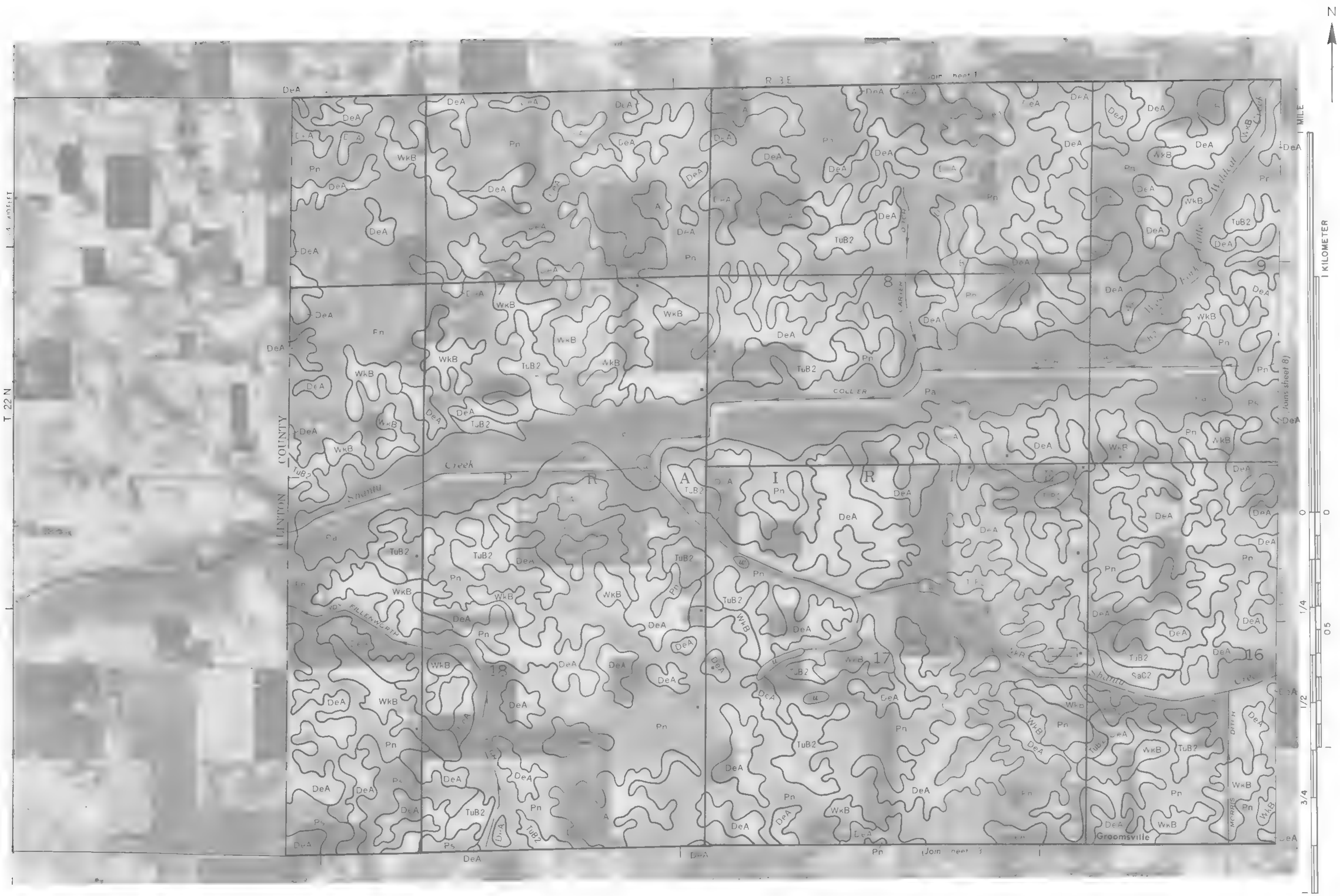


TIPTON COUNTY, INDIANA NO. 5

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

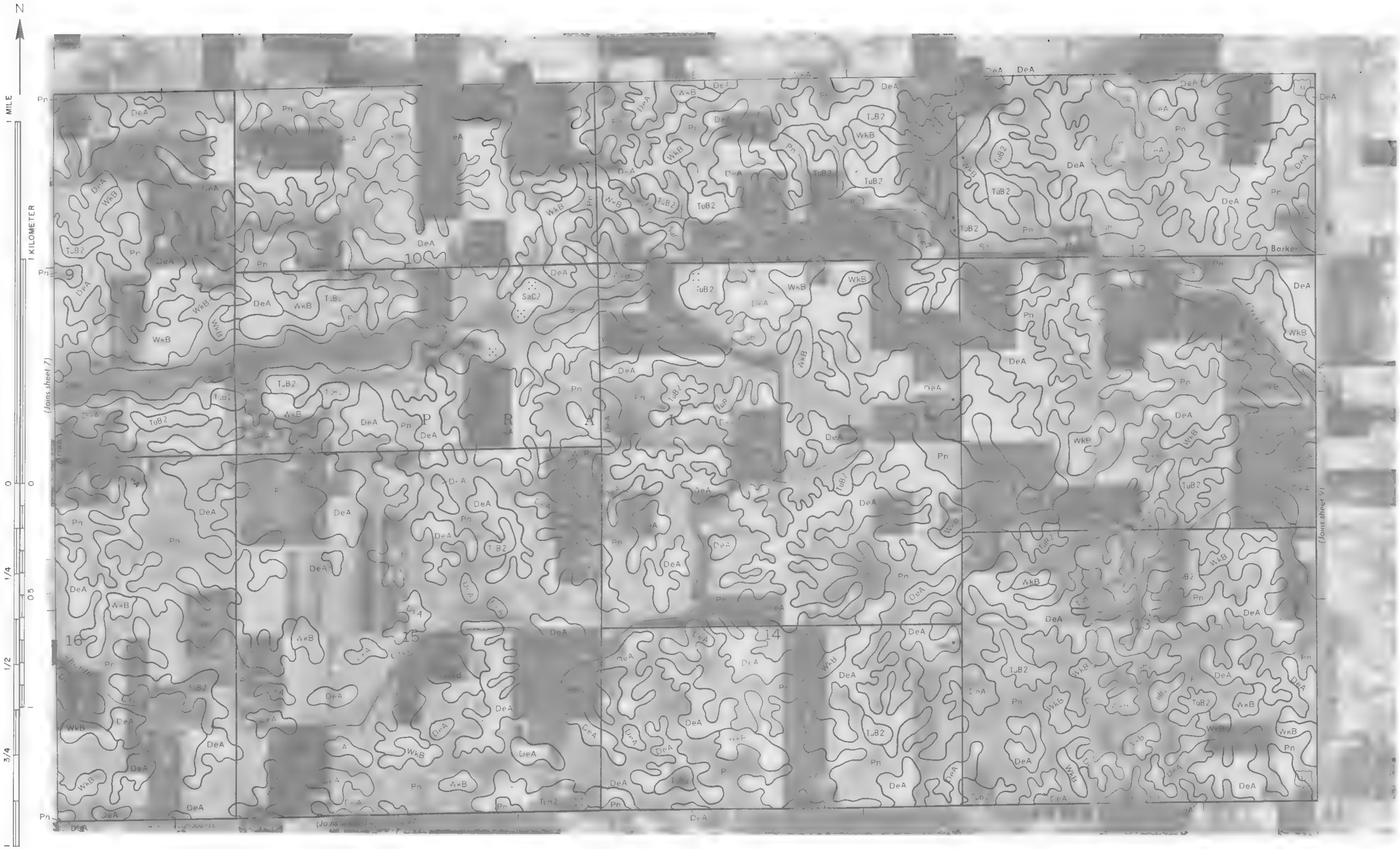
TIPTON COUNTY, INDIANA — SHEET NUMBER 6





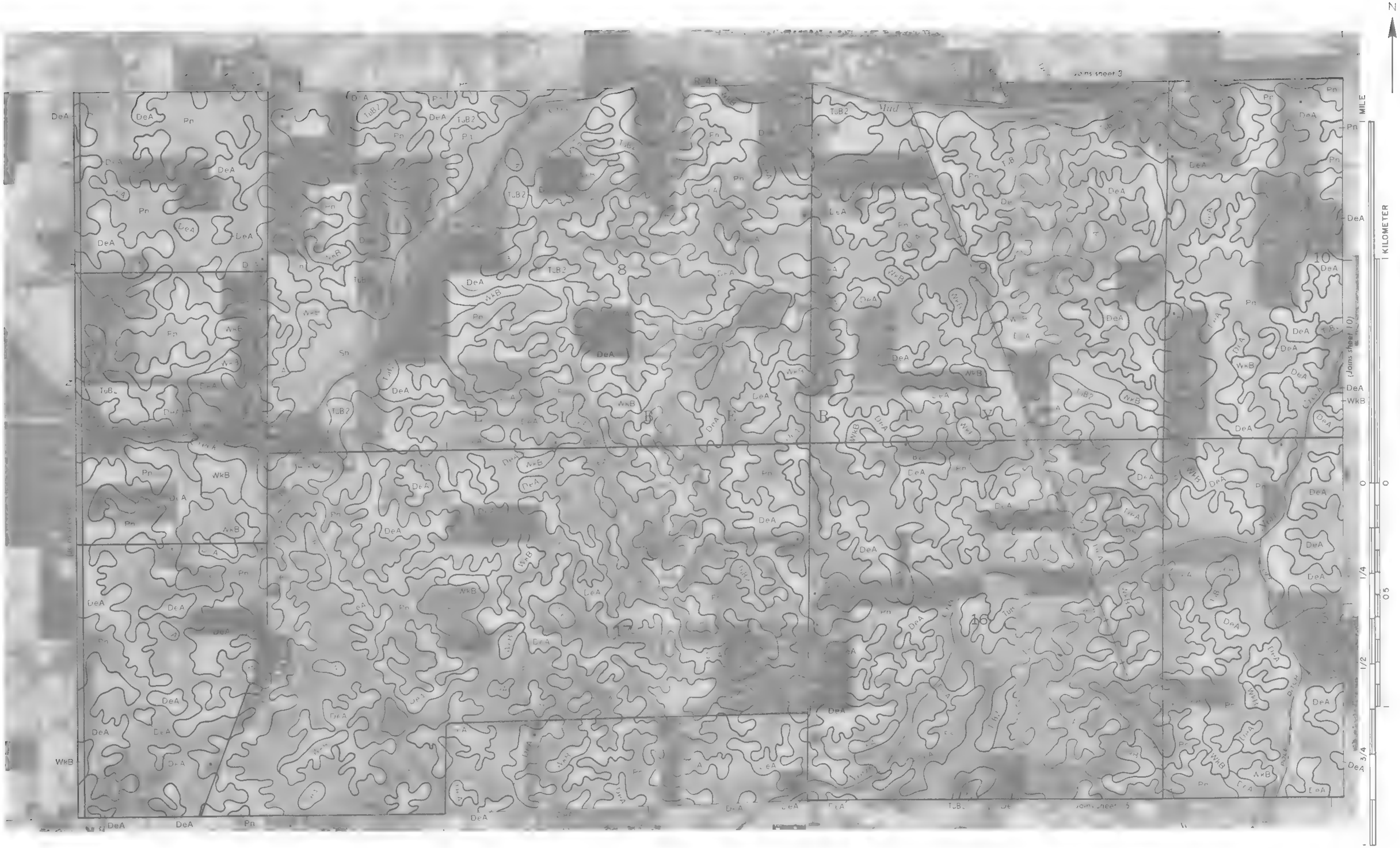
TIPTON COUNTY, INDIANA NO. 7

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



TIPTON COUNTY, INDIANA NO. 8

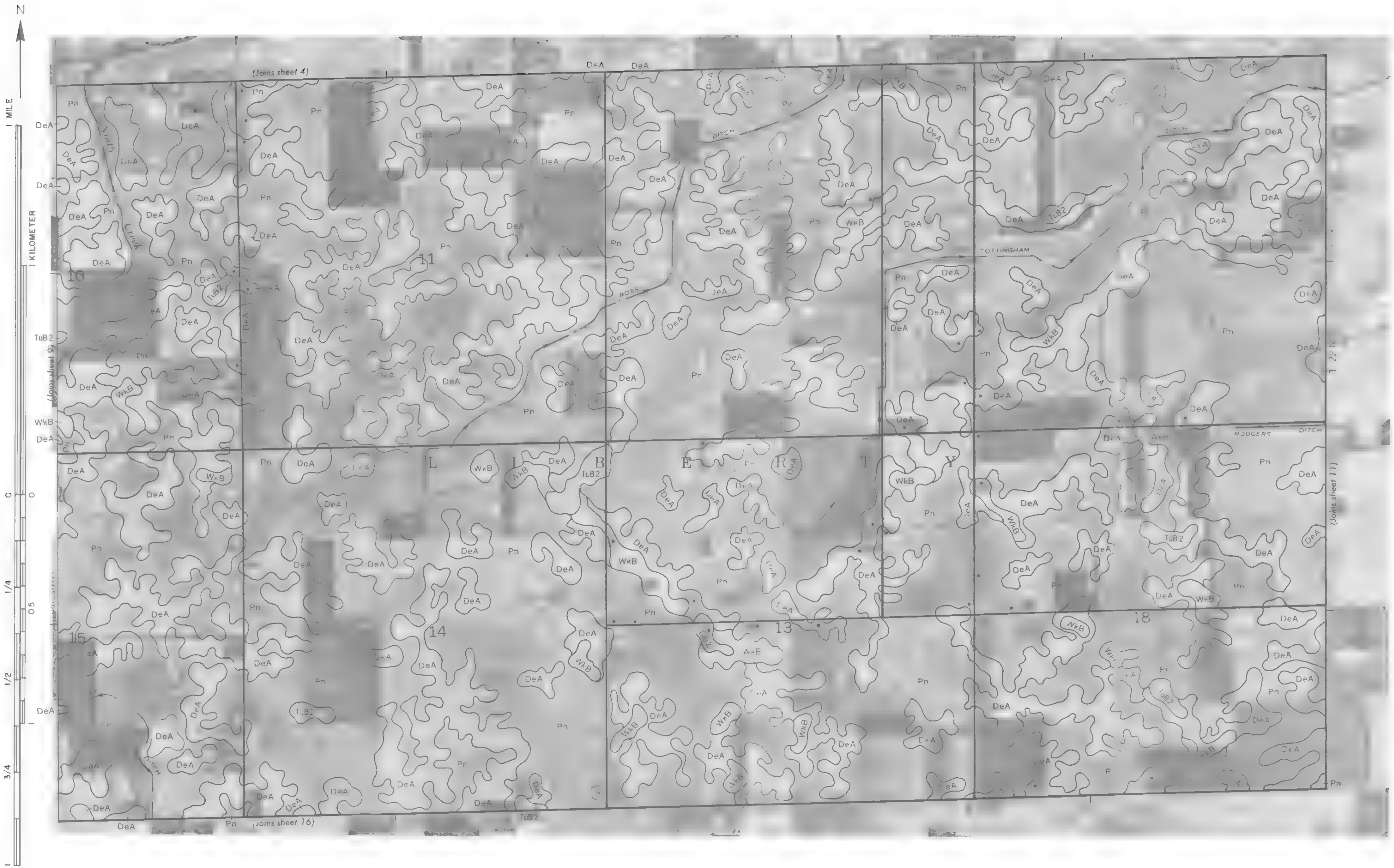
9



TIPTON COUNTY, INDIANA NO. 9

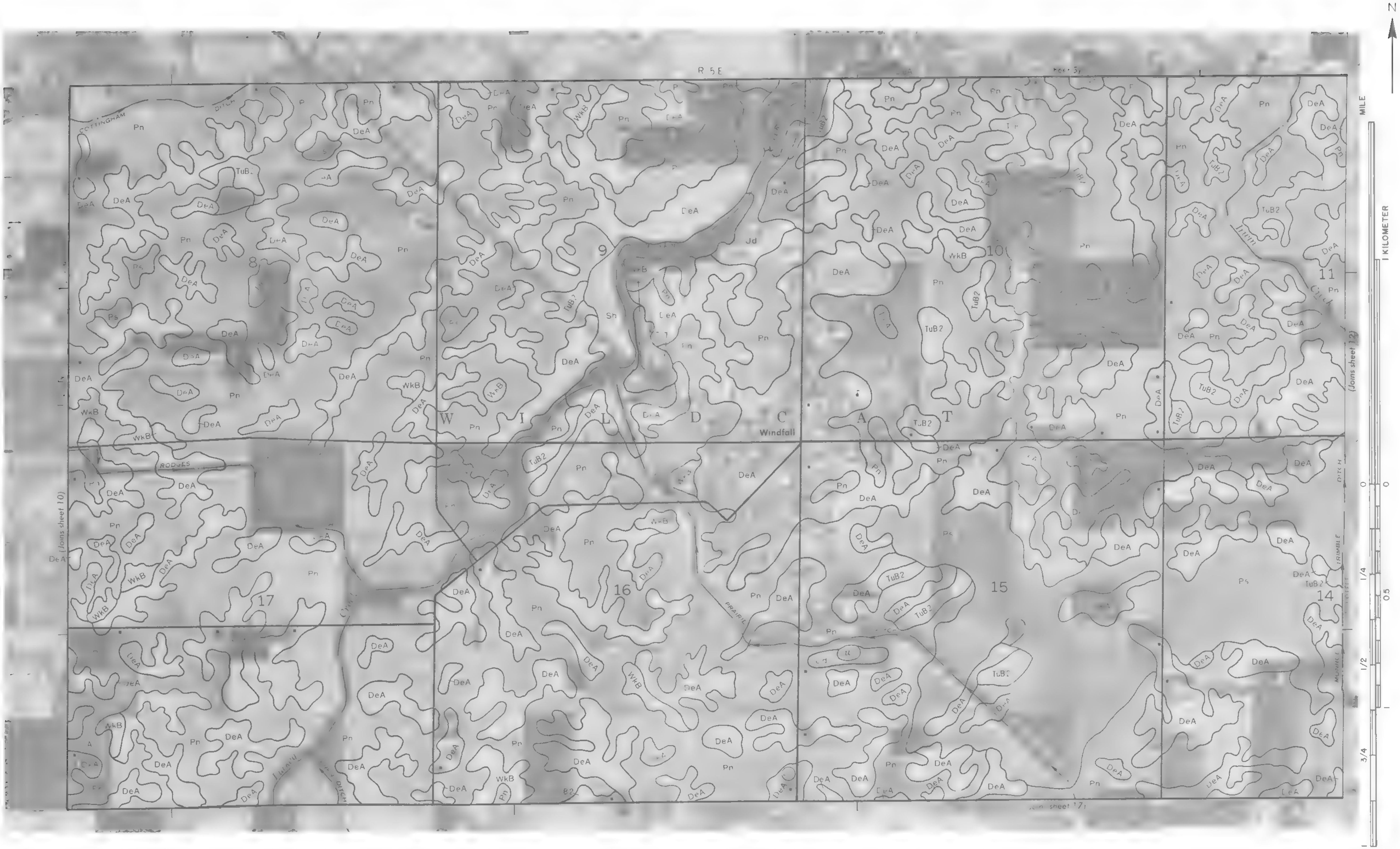
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

TIPTON COUNTY, INDIANA — SHEET NUMBER 10

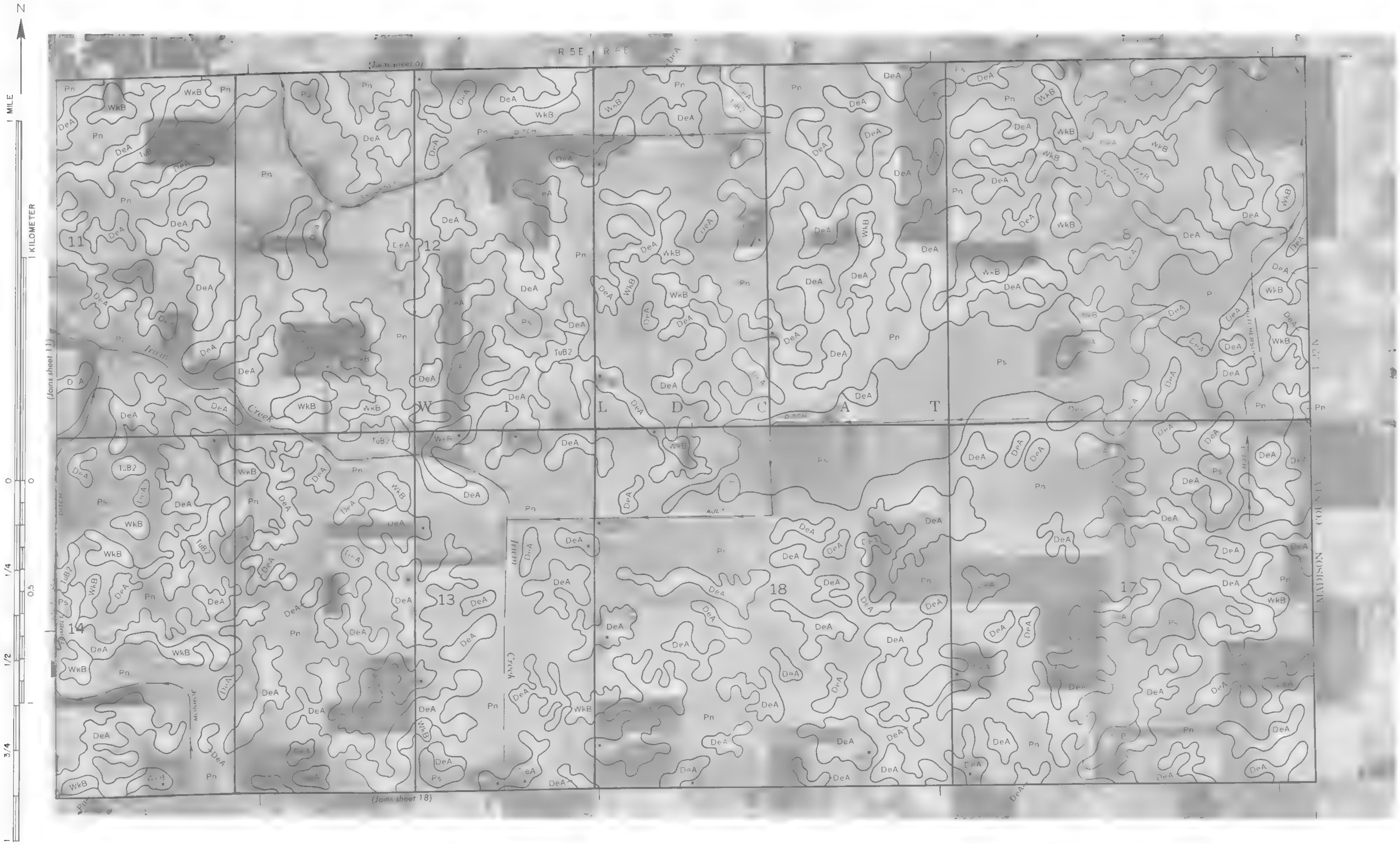


TIPTON COUNTY, INDIANA NO. 10

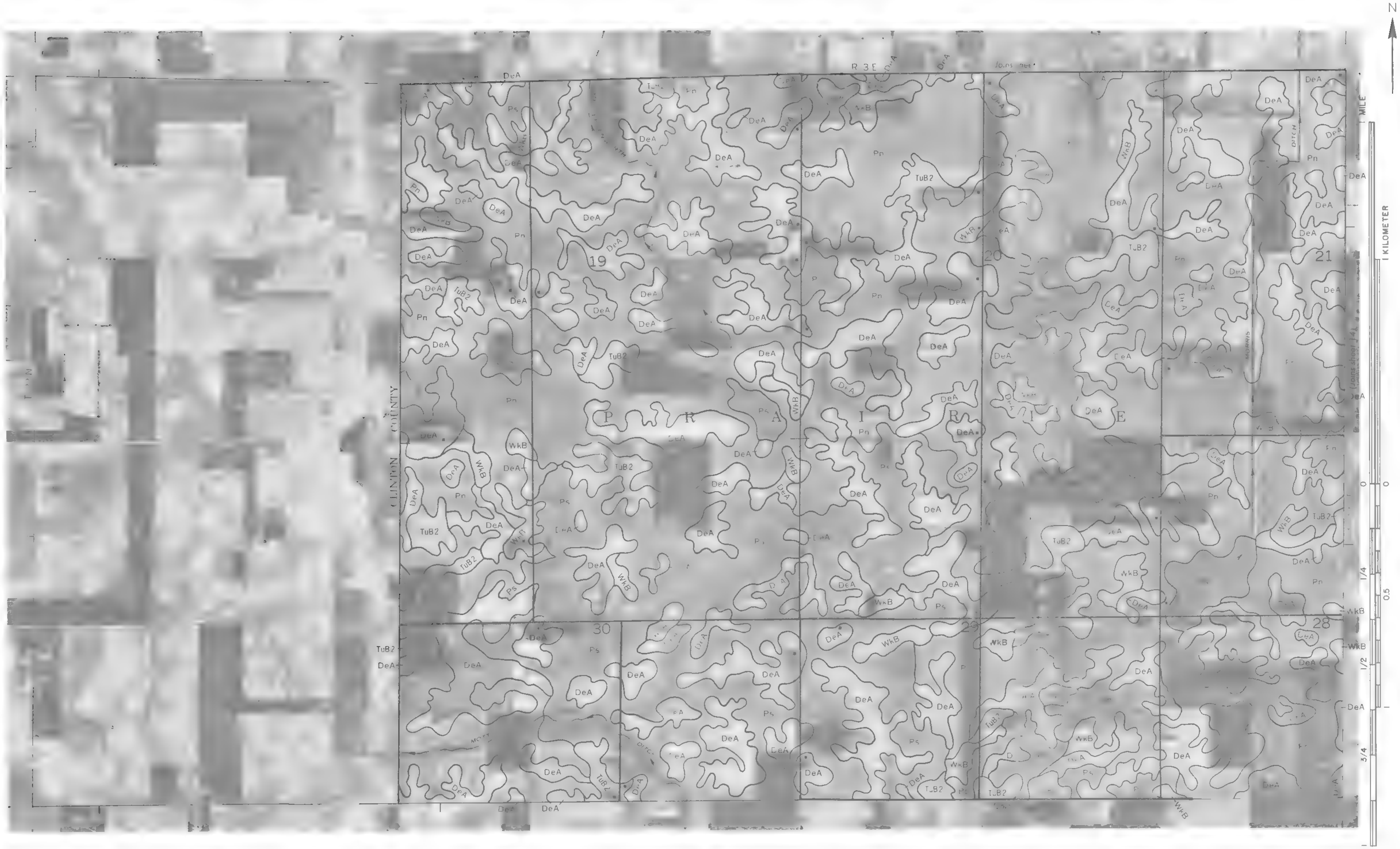
TIPTON COUNTY, INDIANA — SHEET NUMBER 11



TIPTON COUNTY, INDIANA NO. 11

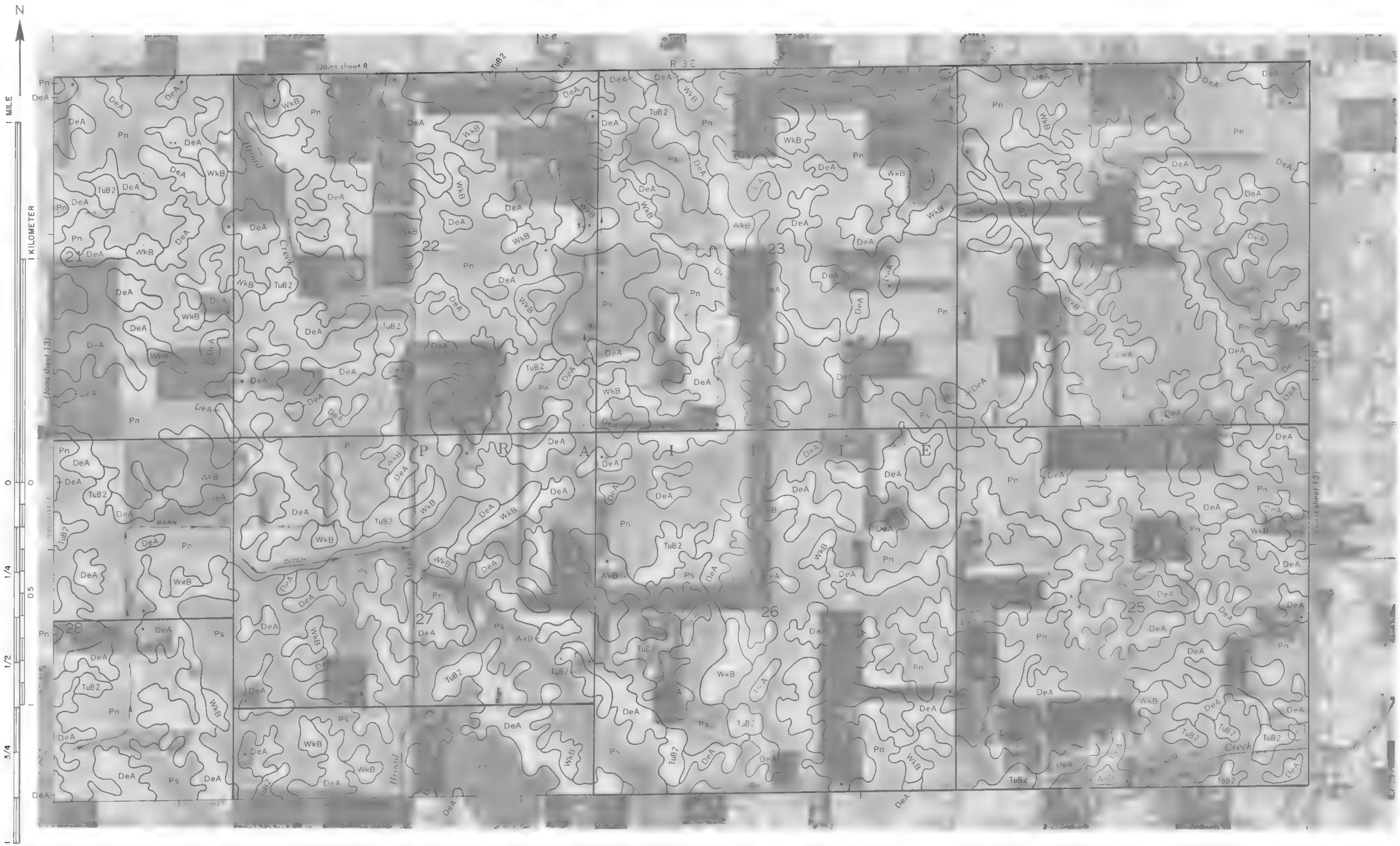

12
N
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
(Joins sheet 6)
(Joins sheet 11)
(Joins sheet 18)
R 5 E
WILDCAT
Creek
MADISON COUNTY
T 22 N

(13)



TIPTON COUNTY, INDIANA NO. 13

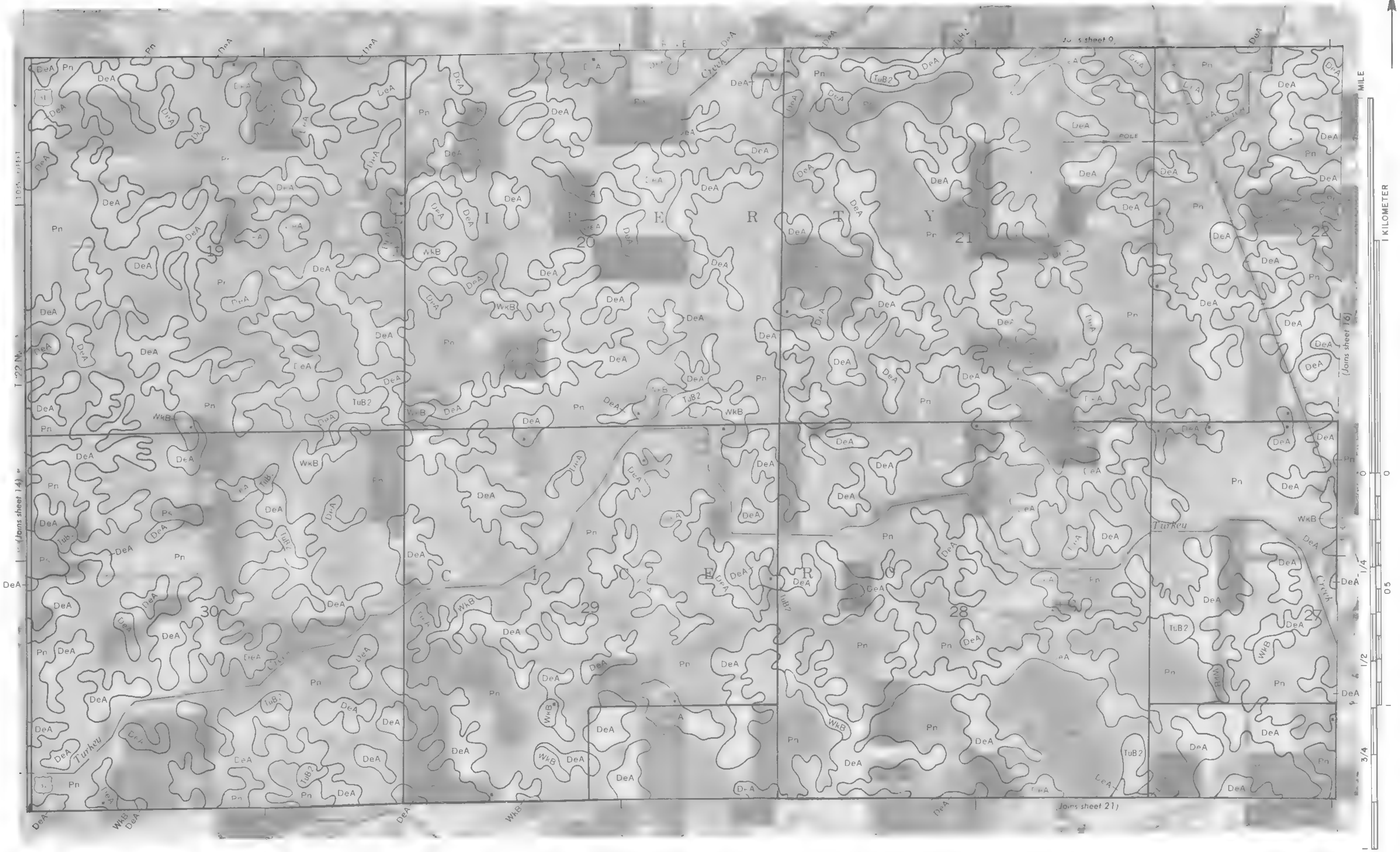
(14)



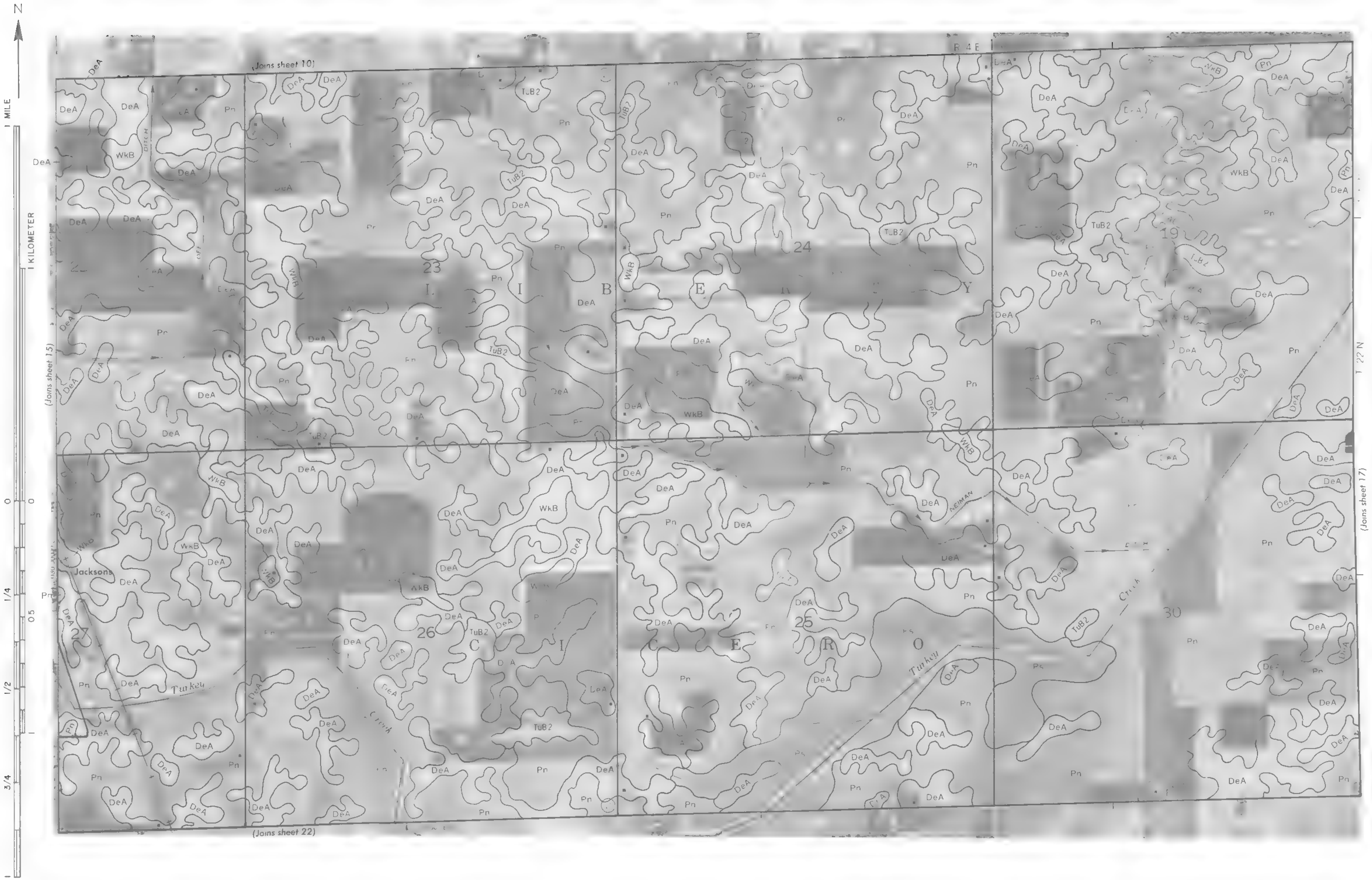
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

TIPTON COUNTY, INDIANA NO. 14

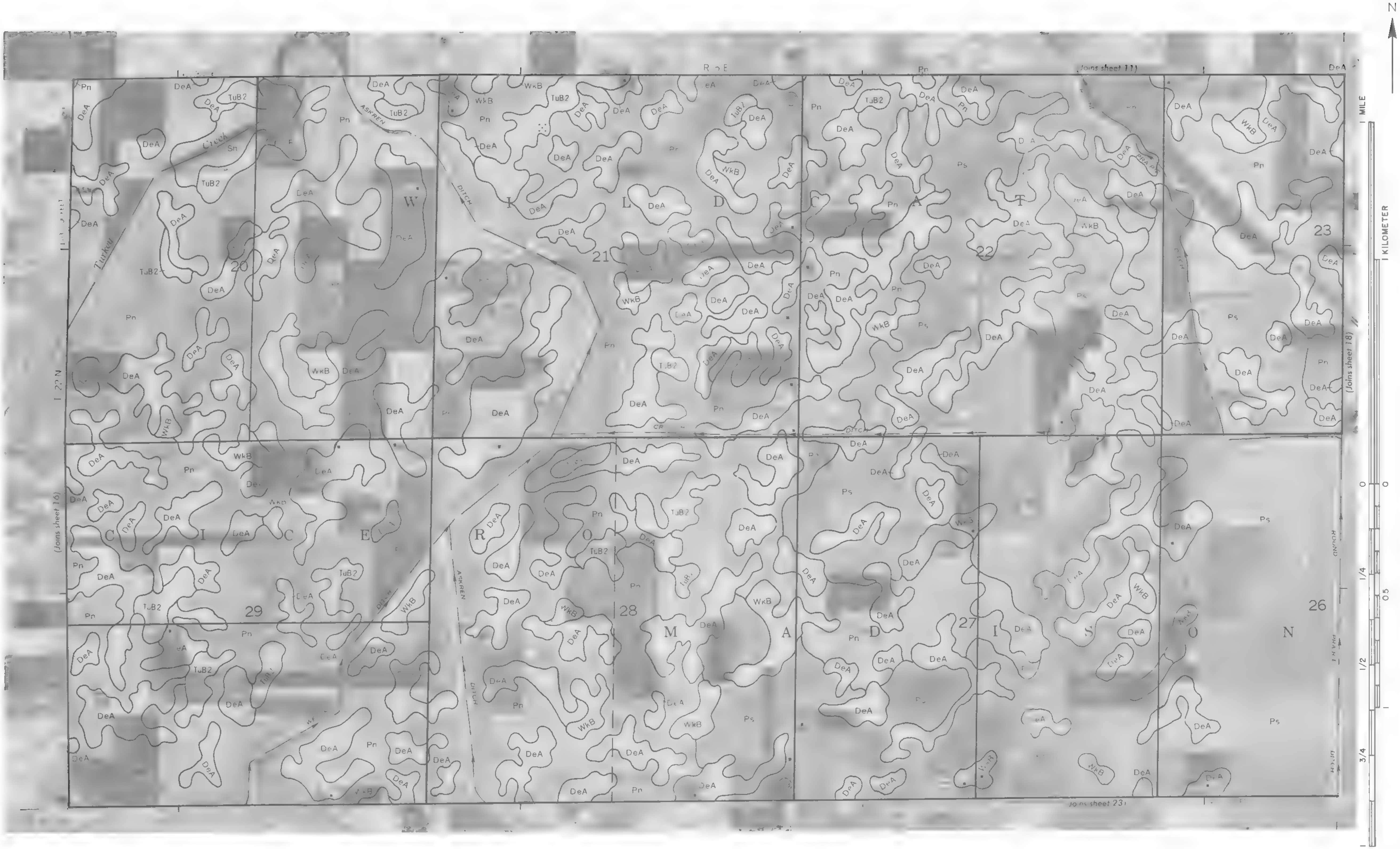
15



TIPTON COUNTY, INDIANA NO. 15



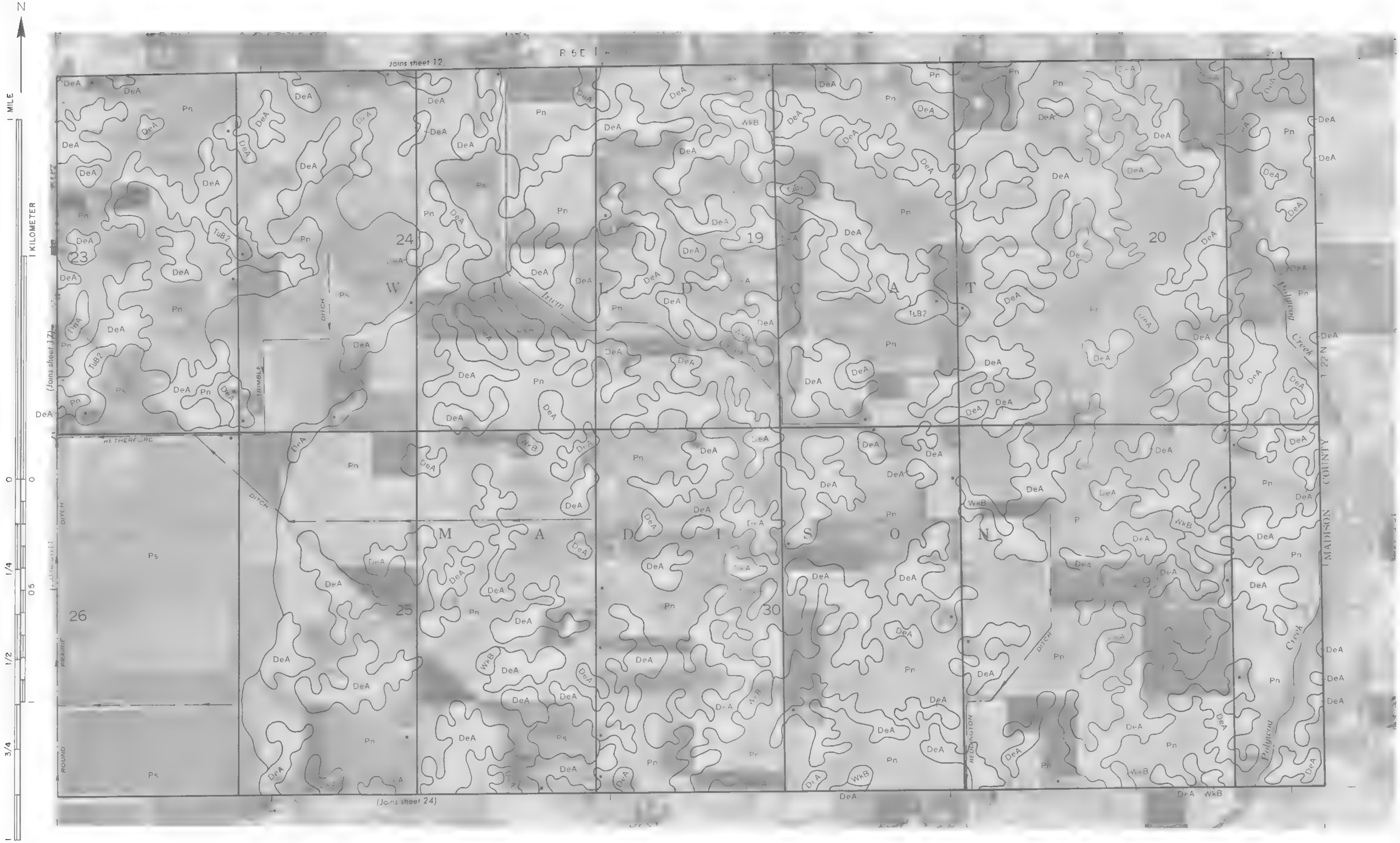
TIPTON COUNTY, INDIANA NO. 16

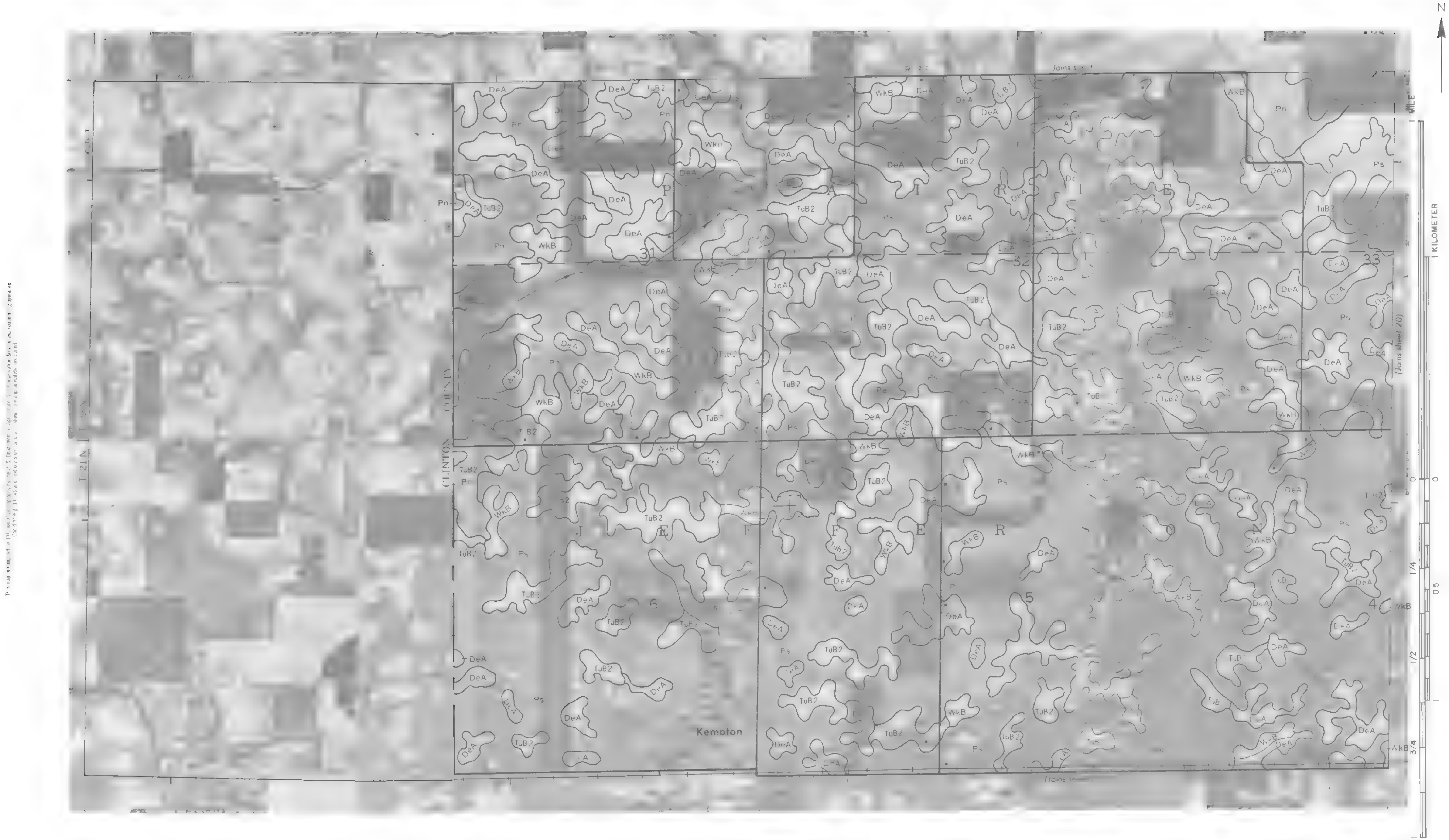


TIPTON COUNTY, INDIANA NO. 17

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(18)

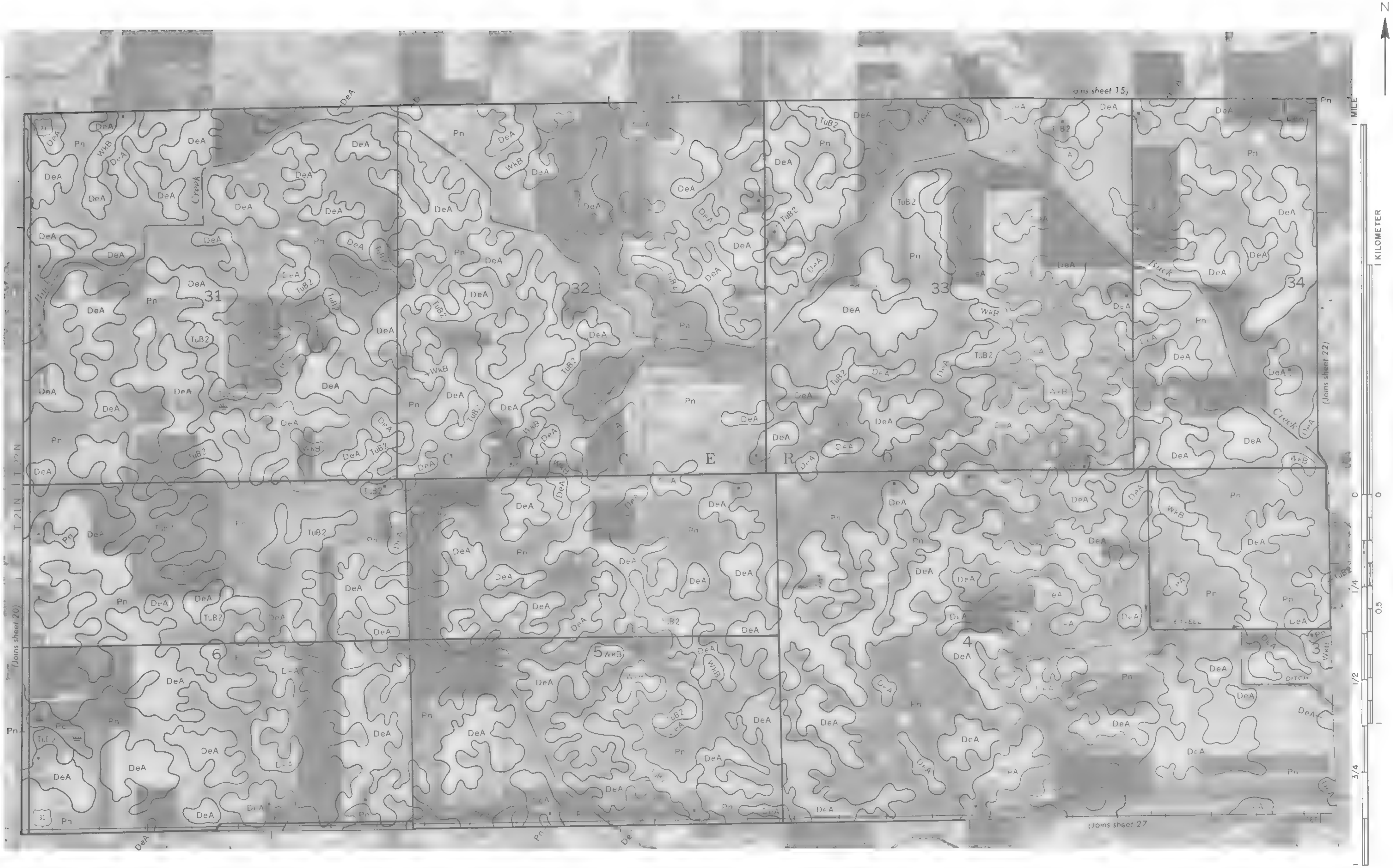

N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
R 5 E
Joins sheet 12
(Joins sheet 17)
(Joins sheet 24)
WILDCAT
MADISON
MADISON COUNTY
T 22 N
23
24
19
20
26
25
30
29
DeA
Pn
Ps
TuB2
WkB
RETHERFORD
DITCH
TRIMBLE
PRAIRIE
ROUND
REDDINGTON
Bousman
Creek
Polywog
Crum

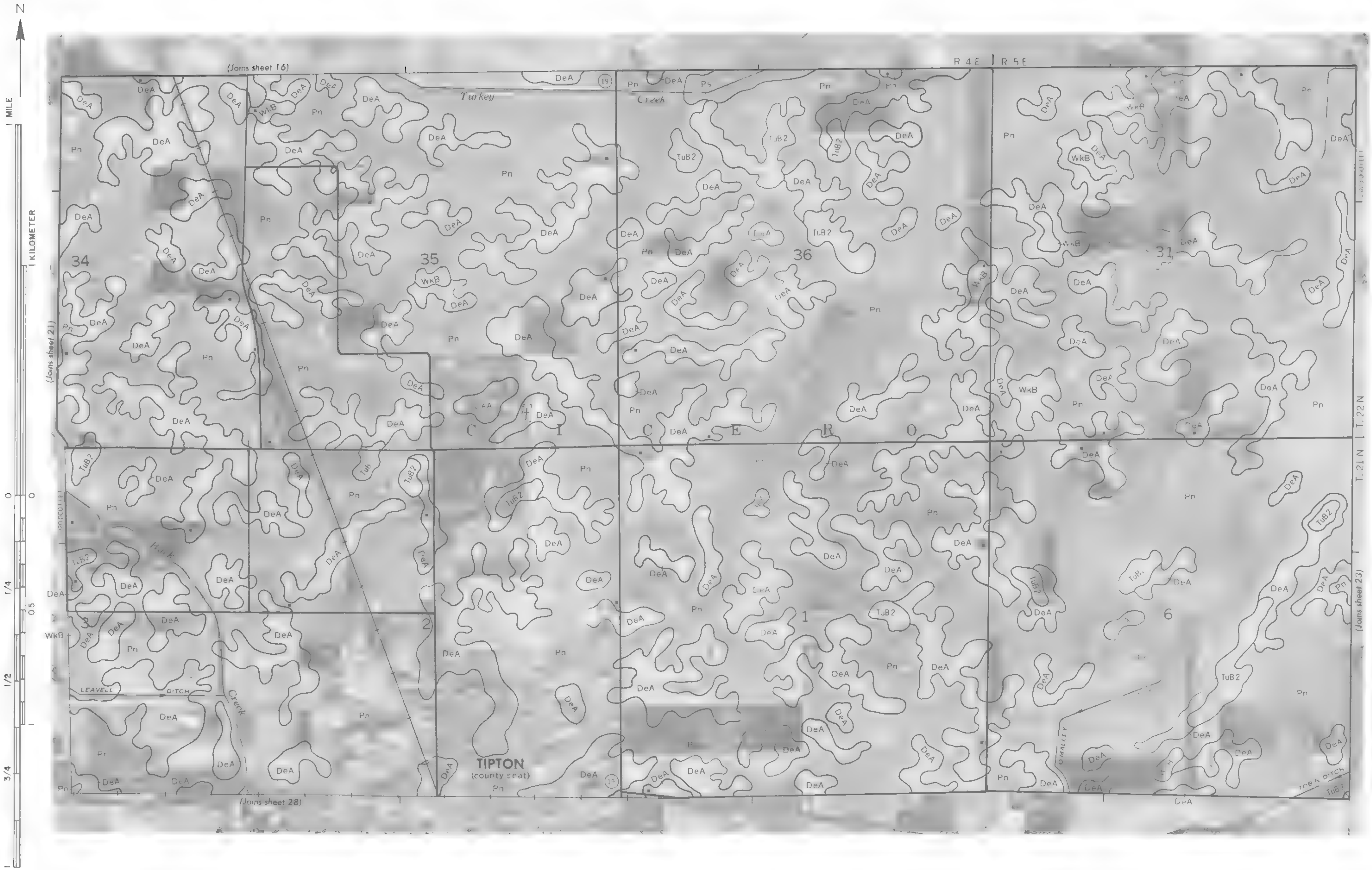

N
Kempton
CLINTON COUNTY
(Joins sheet 20)
P A I R I E
J E F F E R S O N
31
32
33
6
5
4
T. 21 N.
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
DeA
TuB2
WkB
Pn
Ps
TIPTON COUNTY, INDIANA NO. 19

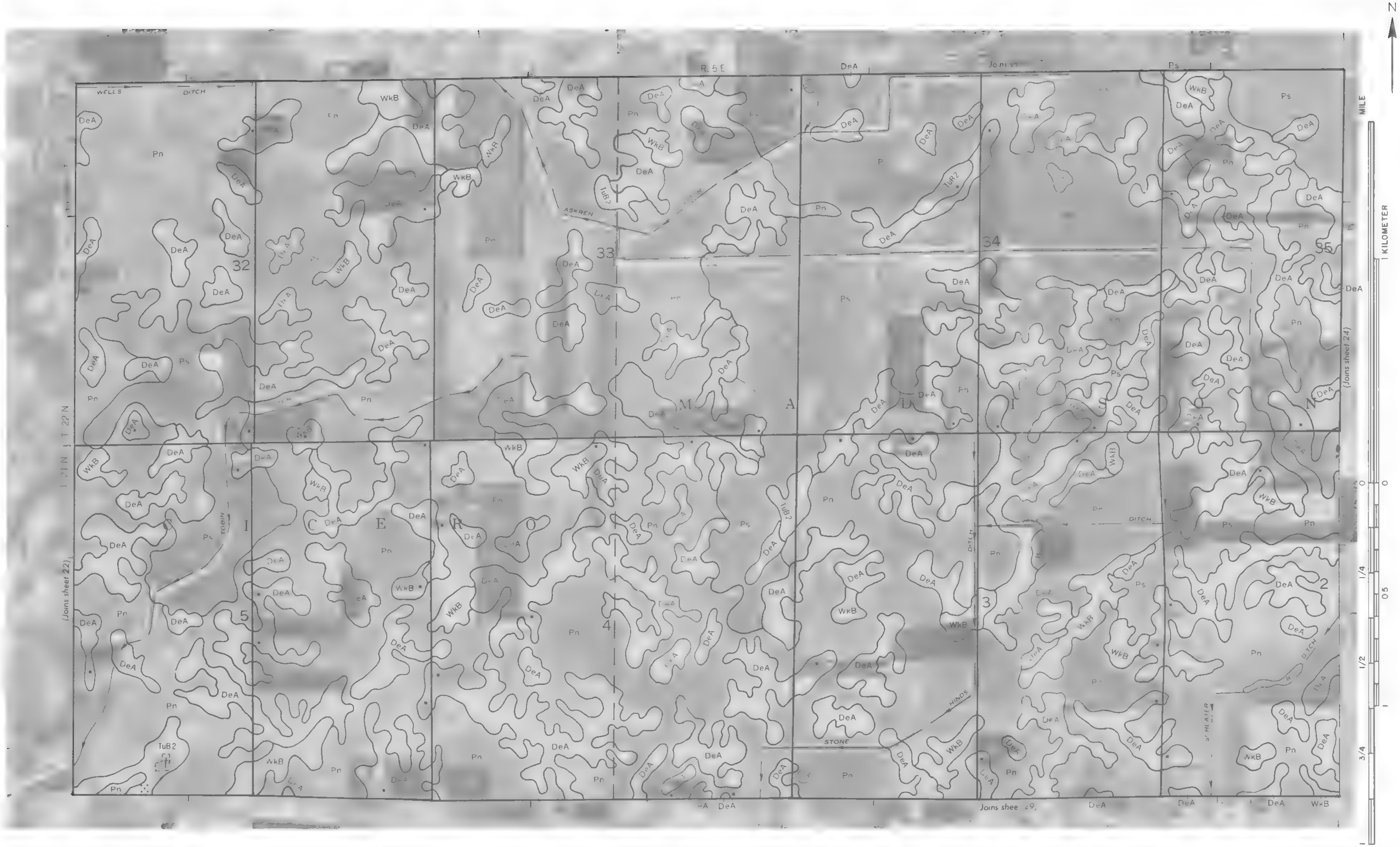
TIPTON COUNTY, INDIANA NO 20

21

TIPTON COUNTY, INDIANA NO. 21

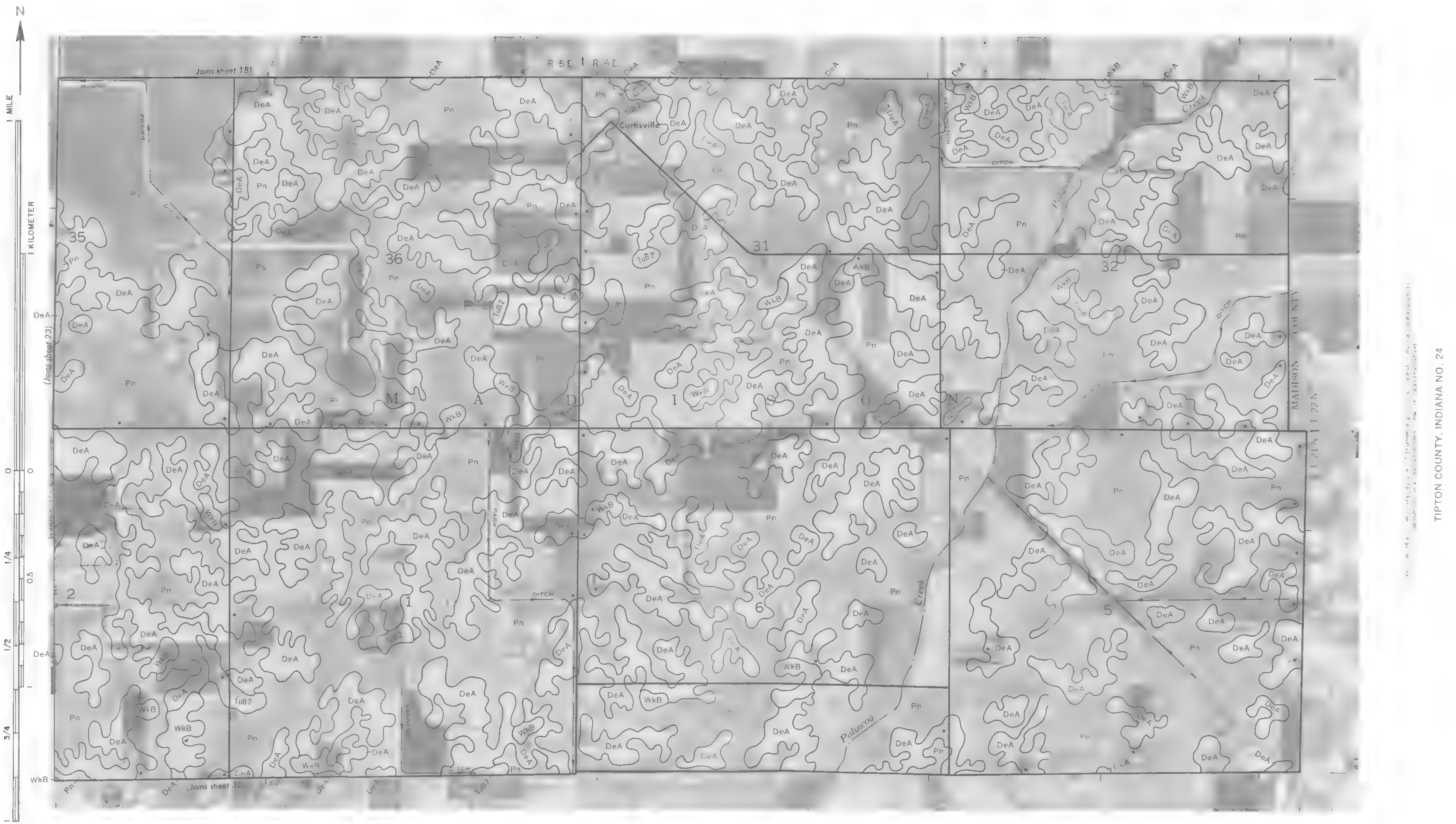


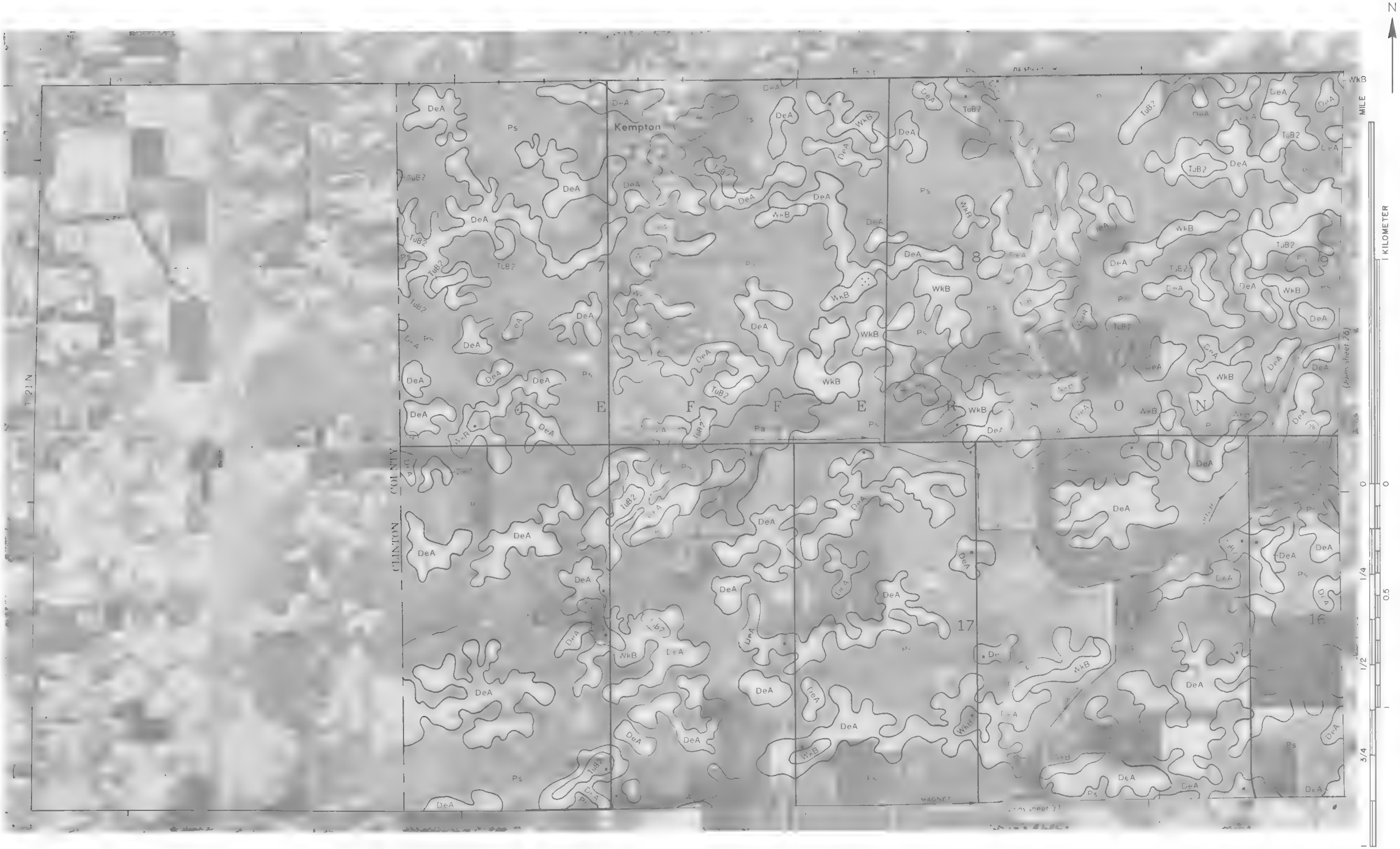

N
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
(Joins sheet 16)
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 28)
R 4 E
R 5 E
T. 22 N
T. 21 N
Turkey
Creek
34
35
36
31
3
2
1
6
C I C E R O
LEAVELL DITCH
Creek
TIPTON
(county seat)
O'MALLEY
TOBIN DITCH
DeA
Pn
WkB
TuB2



TIPTON COUNTY, INDIANA NO. 23

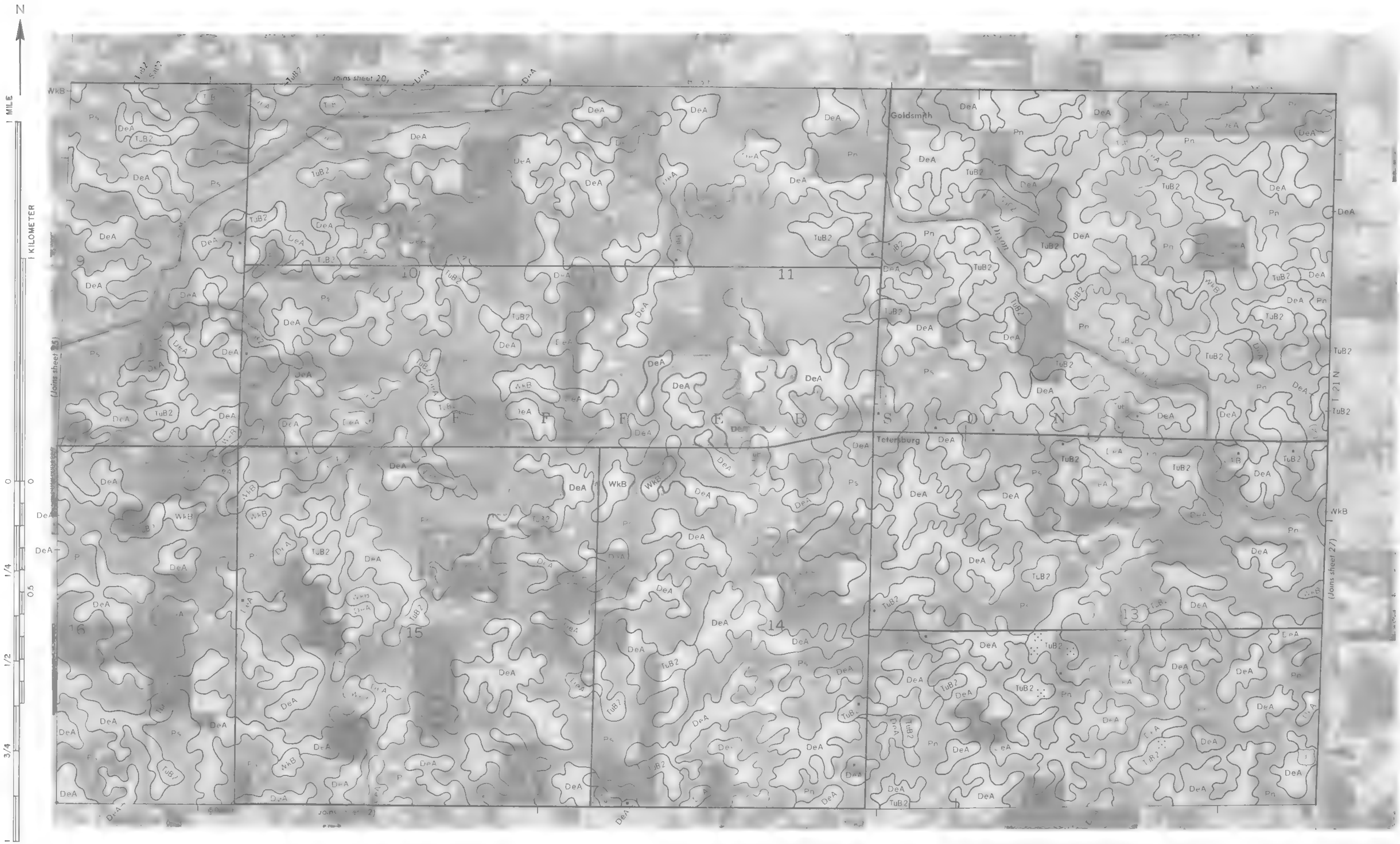
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


24
N
1 MILE
1 KILOMETER
Joins sheet 18
R 5 E | R 6 E
(Joins sheet 23)
Joins sheet 30
Curtisville
M A D I S O N
MADISON COUNTY
T 21 N | T 22 N
Polywog Creek
DITCH
35
36
31
32
2
1
6
5

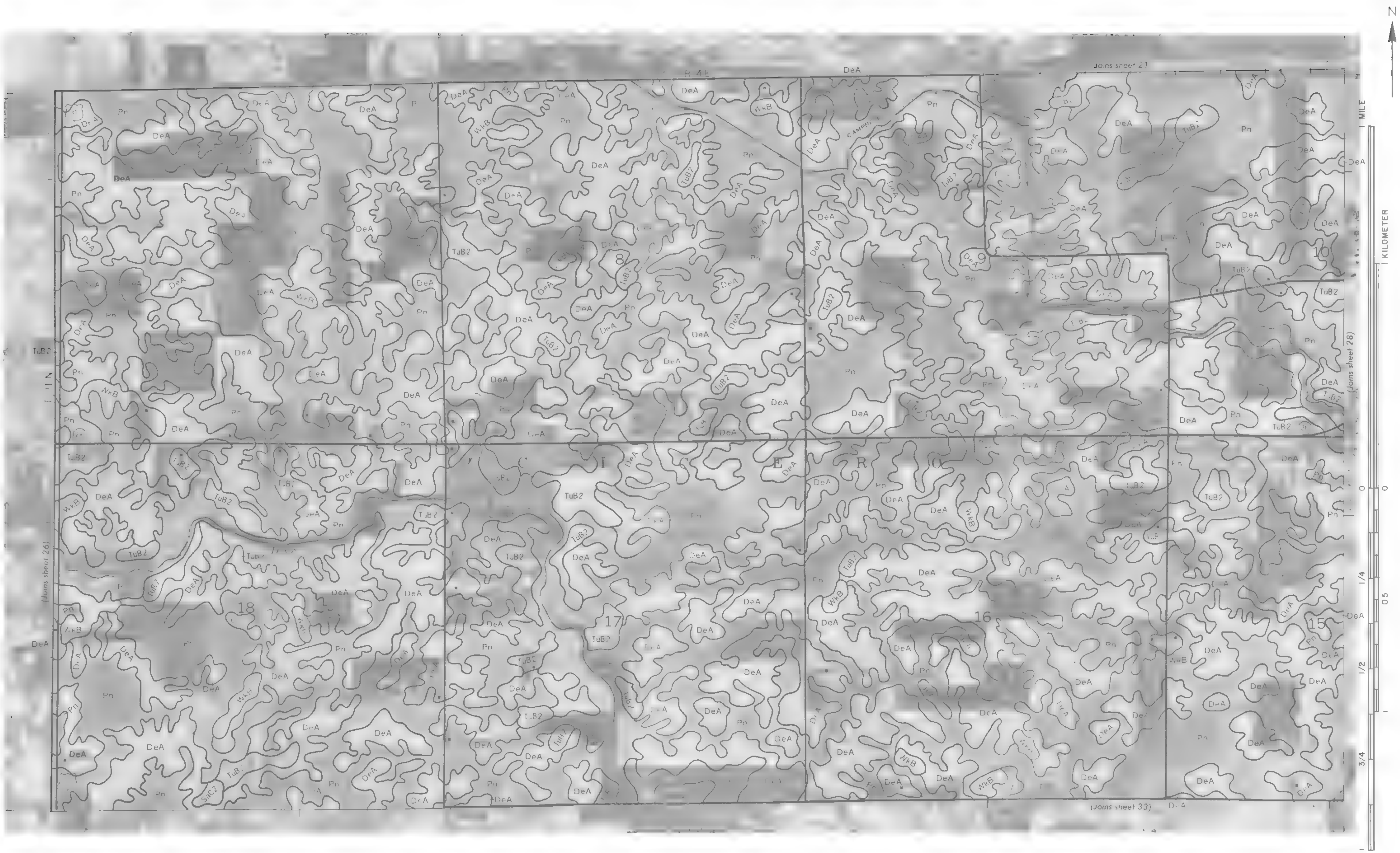


TIPTON COUNTY, INDIANA NO. 25

This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

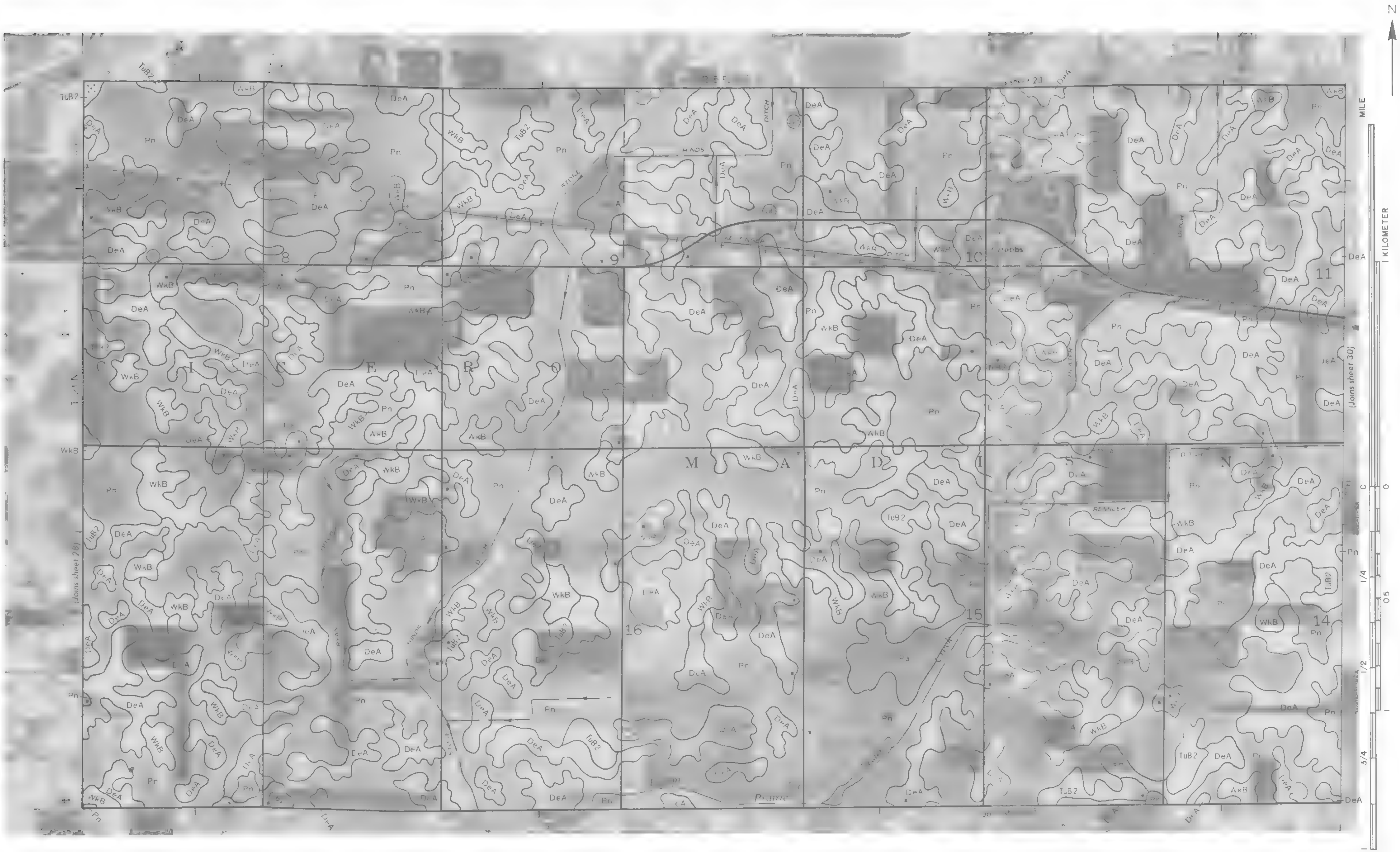

N
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
(Joins sheet 20)
(Joins sheet 25)
(Joins sheet 27)
Joins sheet 27
Goldsmith
Tetersburg
J E F F E R S O N
9
10
11
12
13
14
15
16
T. 21 N.

TIPTON COUNTY, INDIANA NO. 27



TIPTON COUNTY, INDIANA — SHEET NUMBER 28

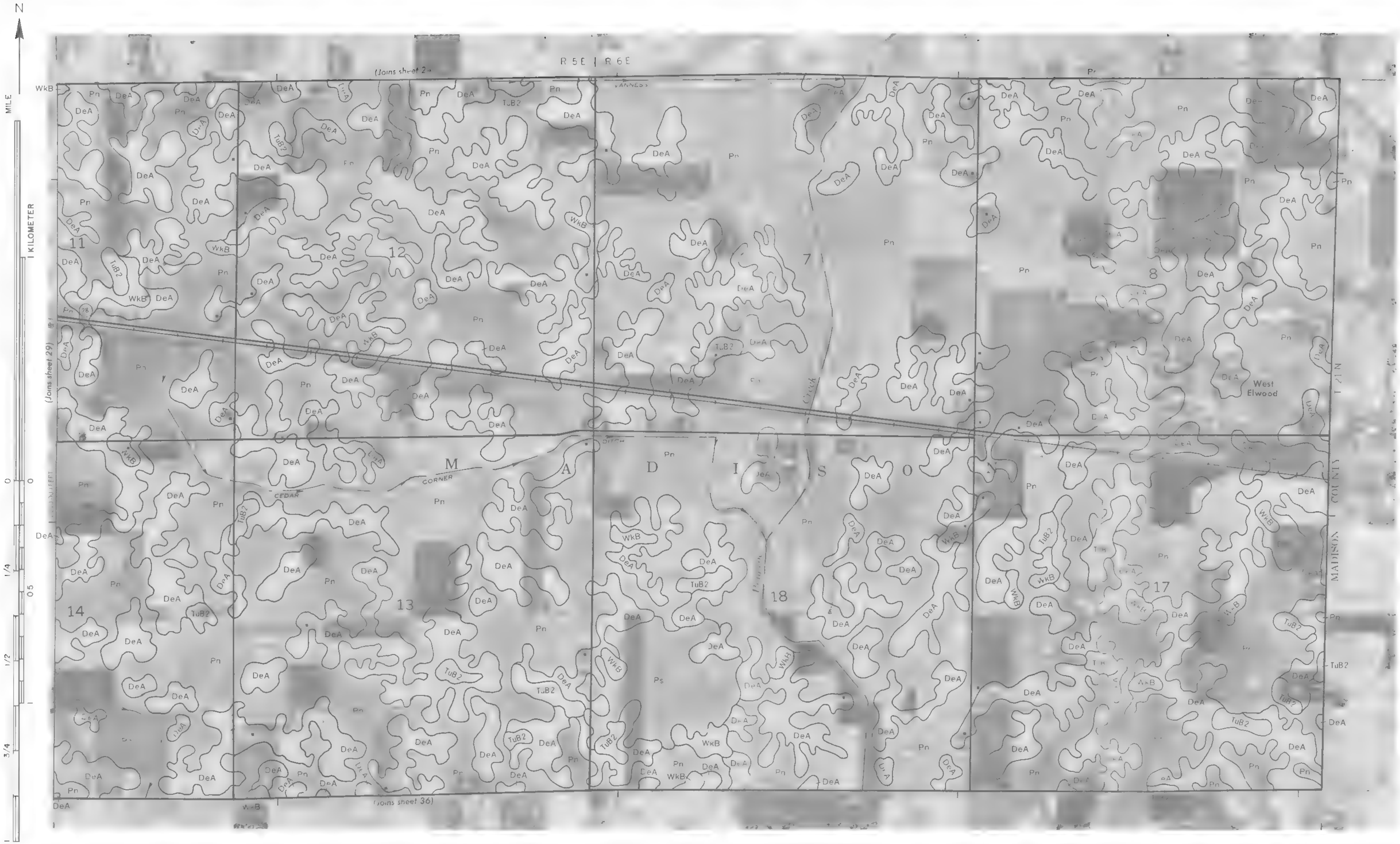
TIPTON COUNTY, INDIANA NO. 28



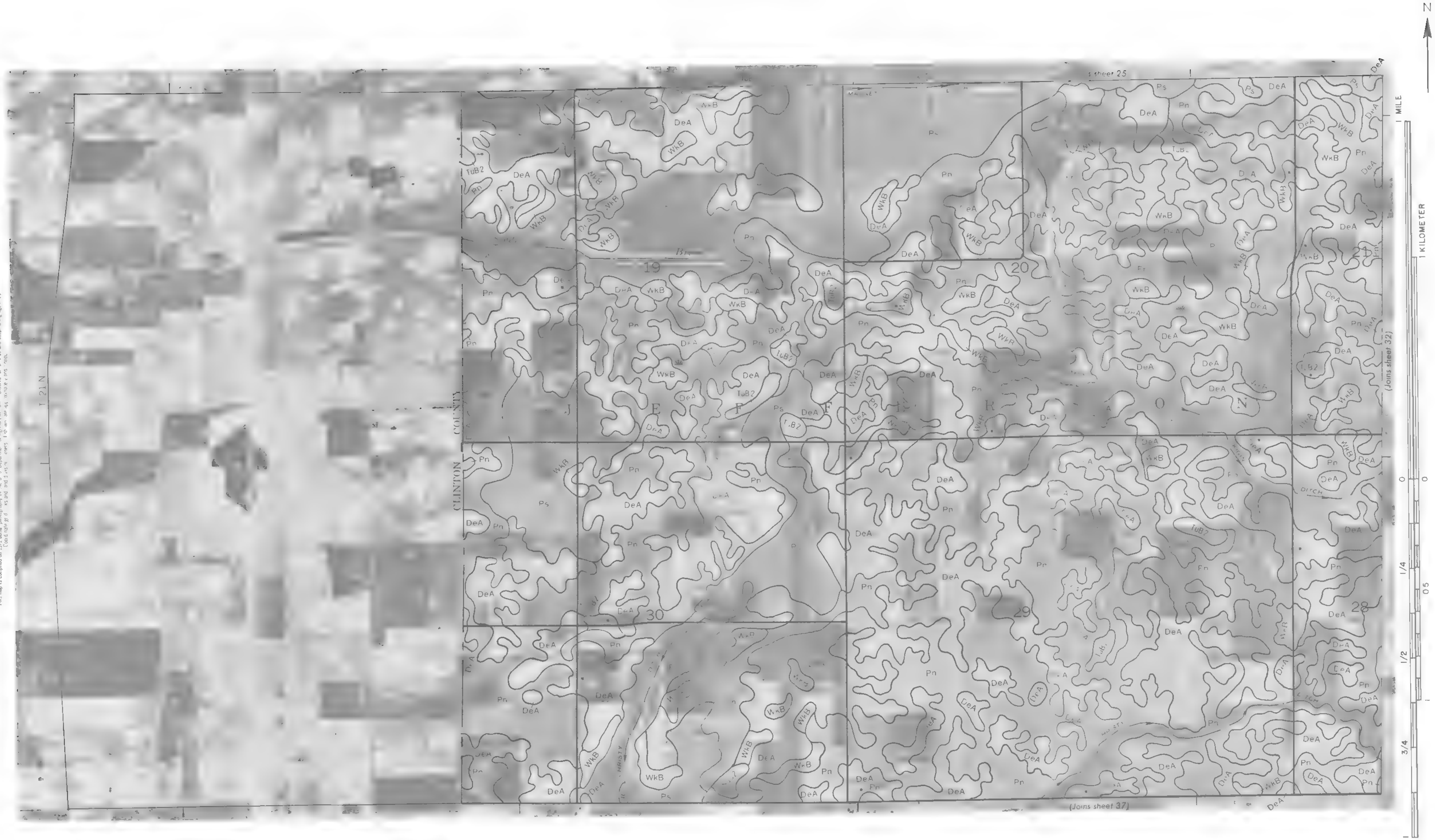
TIPTON COUNTY, INDIANA NO. 29

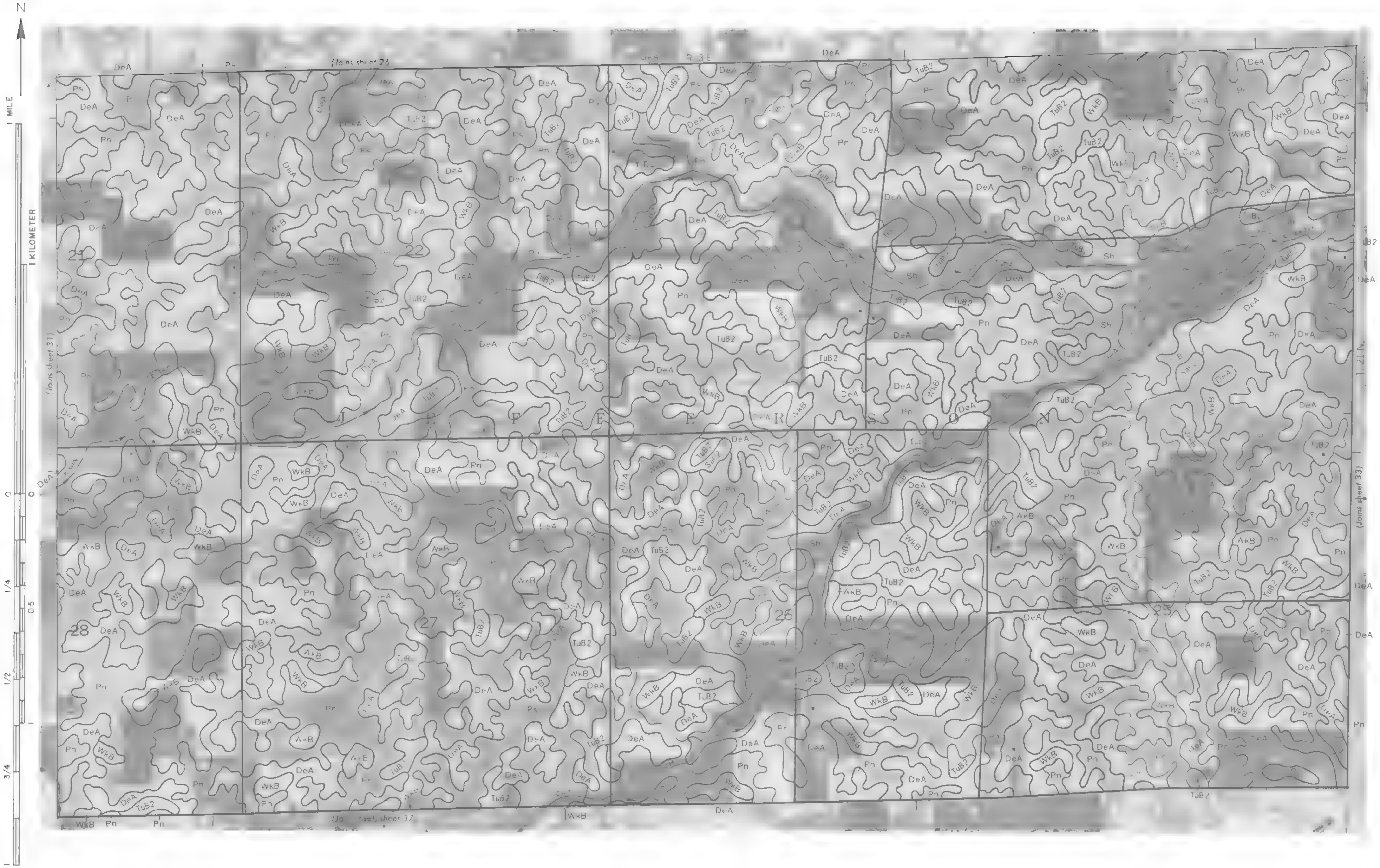
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

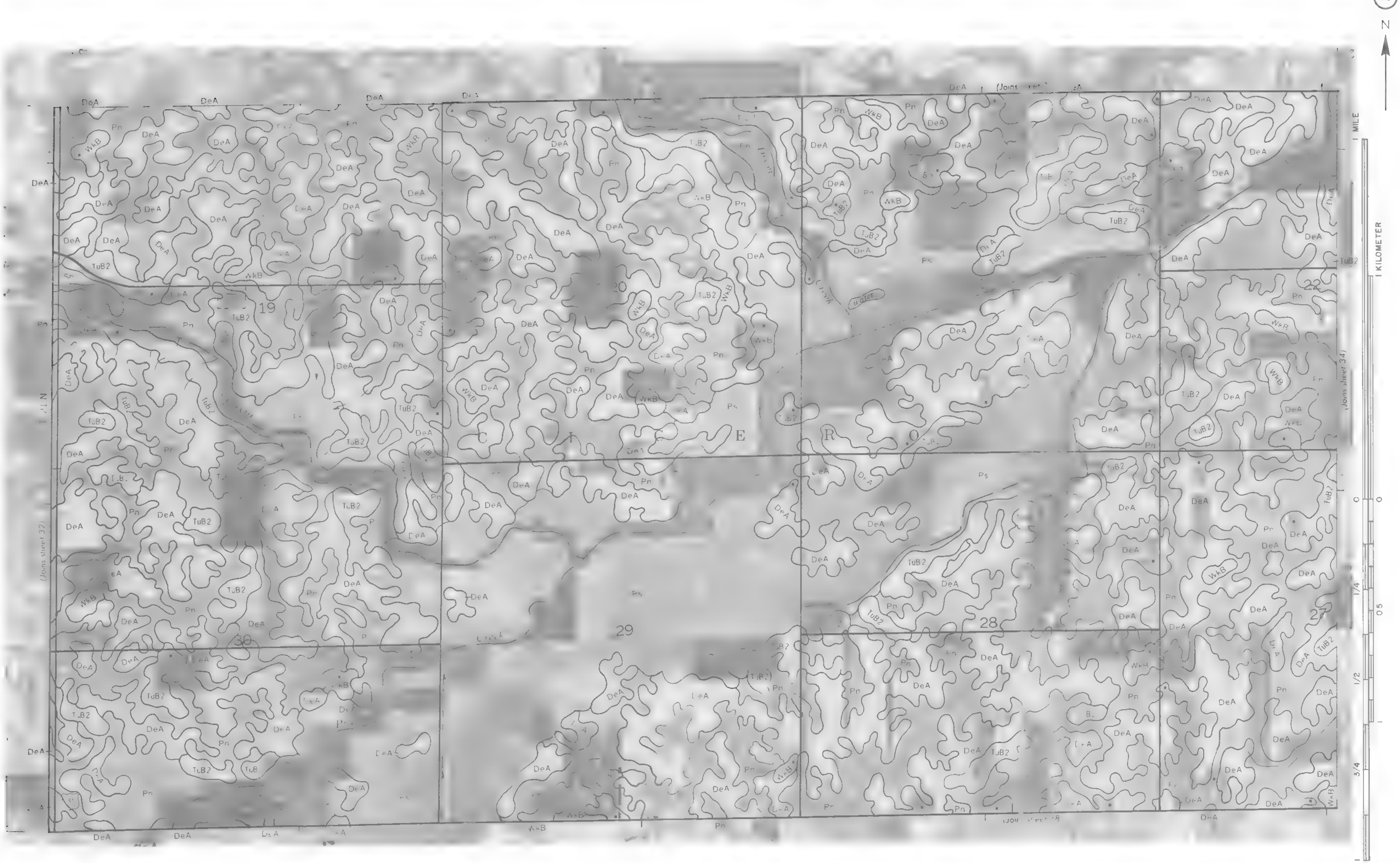
TIPTON COUNTY, INDIANA — SHEET NUMBER 30



TIPTON COUNTY, INDIANA NO. 31



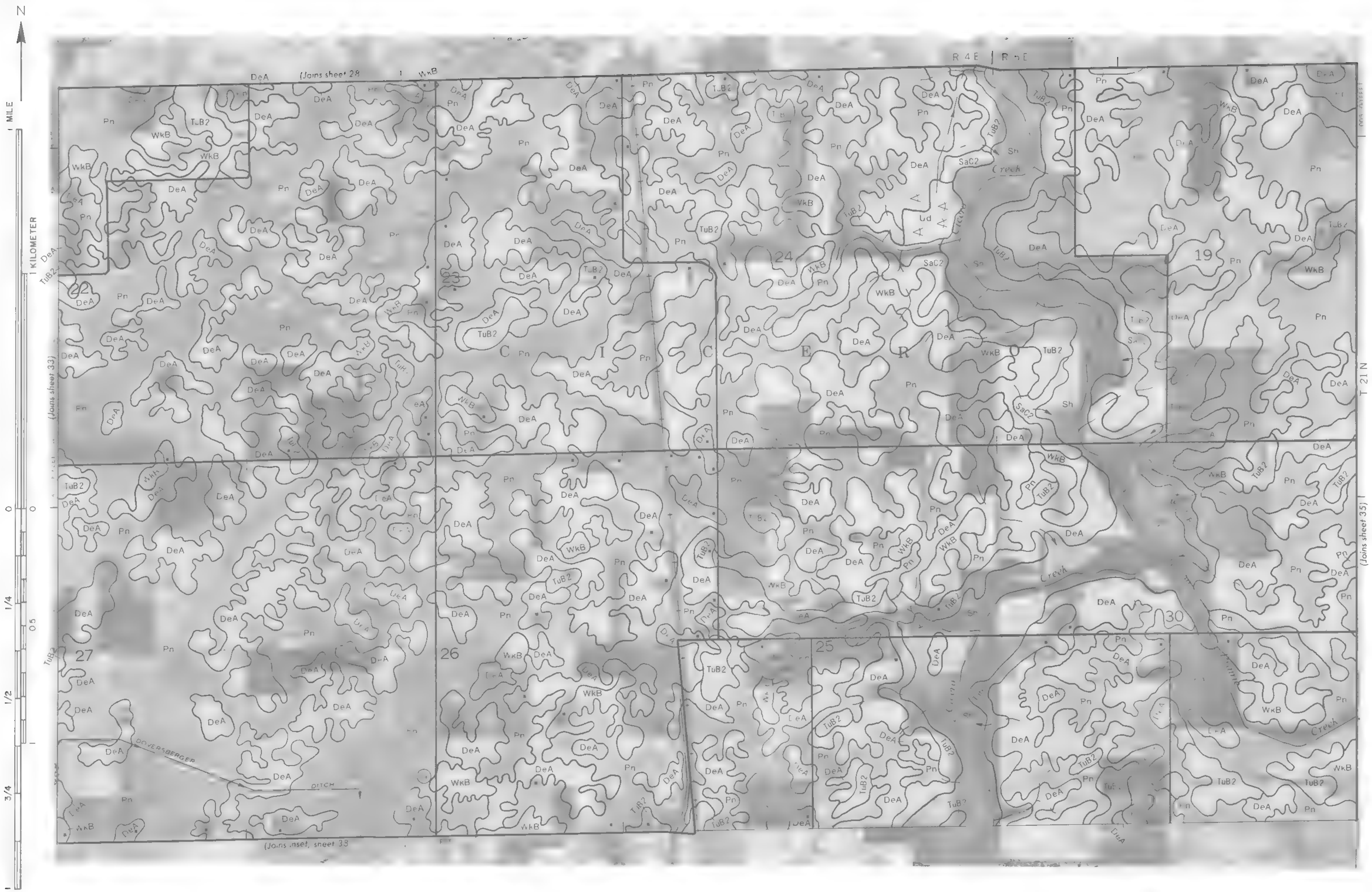

N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
(Joins sheet 26)
(Joins sheet 31)
(Joins sheet 33)
R. 3 E.
T. 21 N.
21
22
23
24
25
26
27
28
J E F F E R S O N
DeA
Pn
WkB
TuB2
Sh



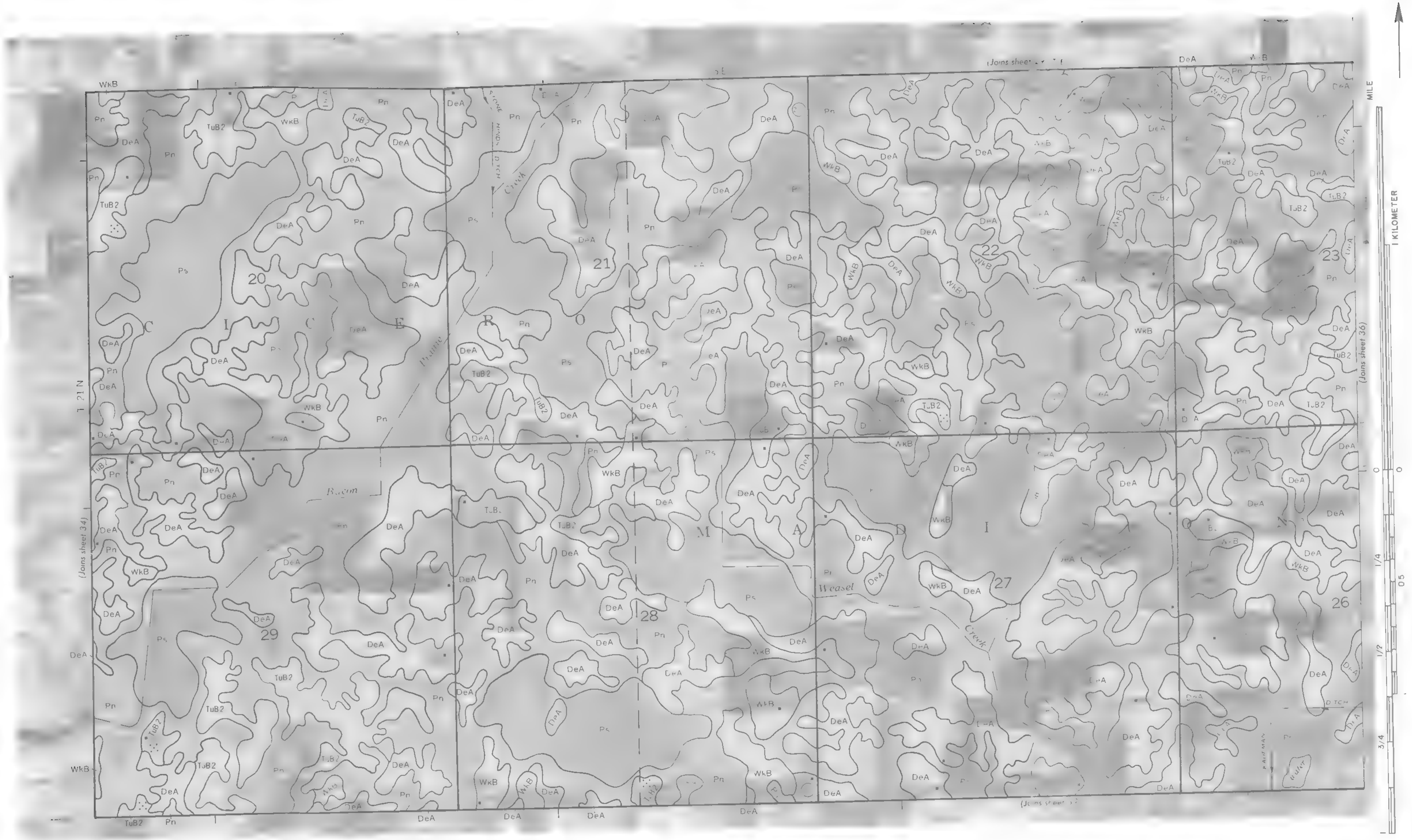
TIPTON COUNTY, INDIANA NO. 33

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

TIPTON COUNTY, INDIANA — SHEET NUMBER 34

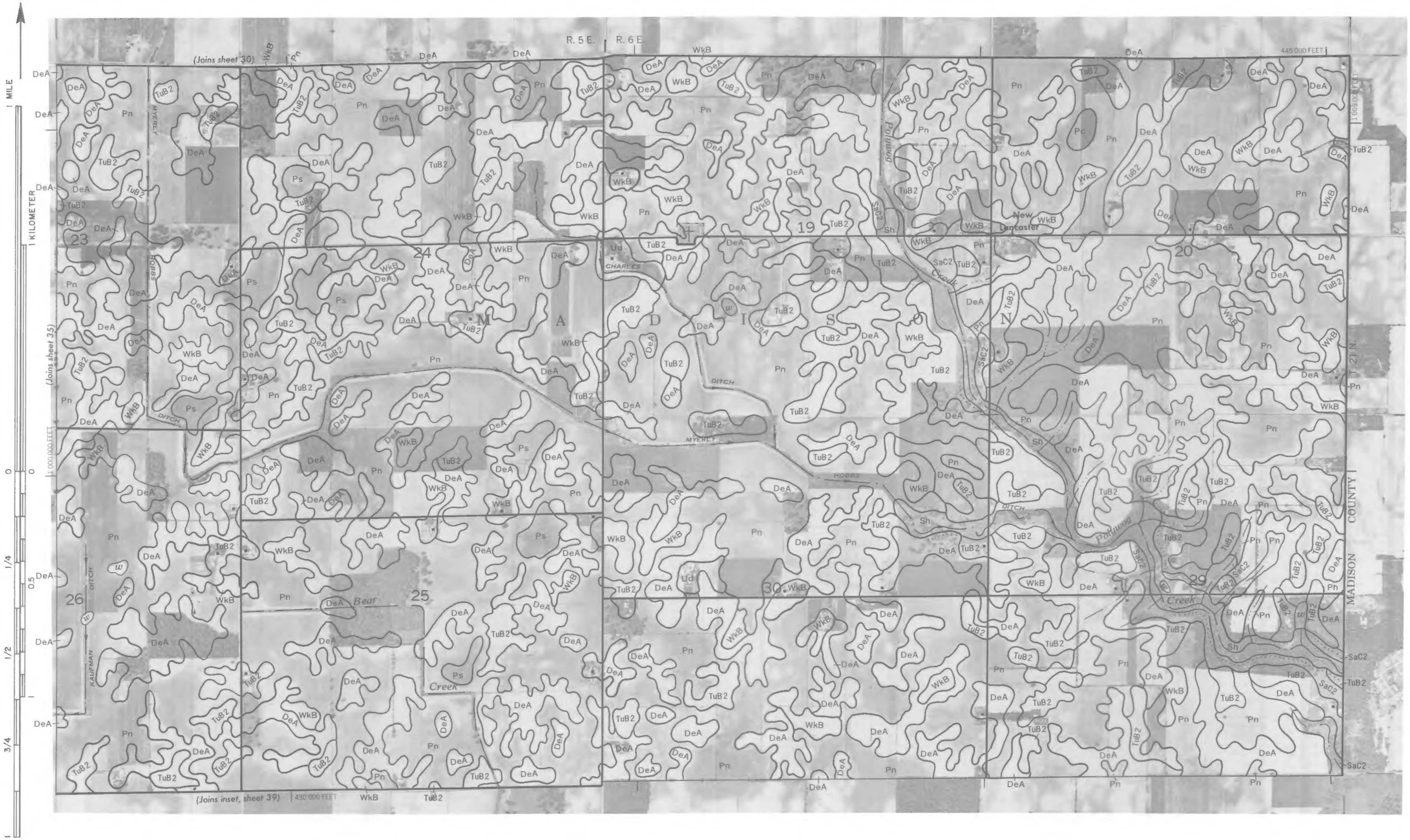


TIPTON COUNTY, INDIANA NO. 34



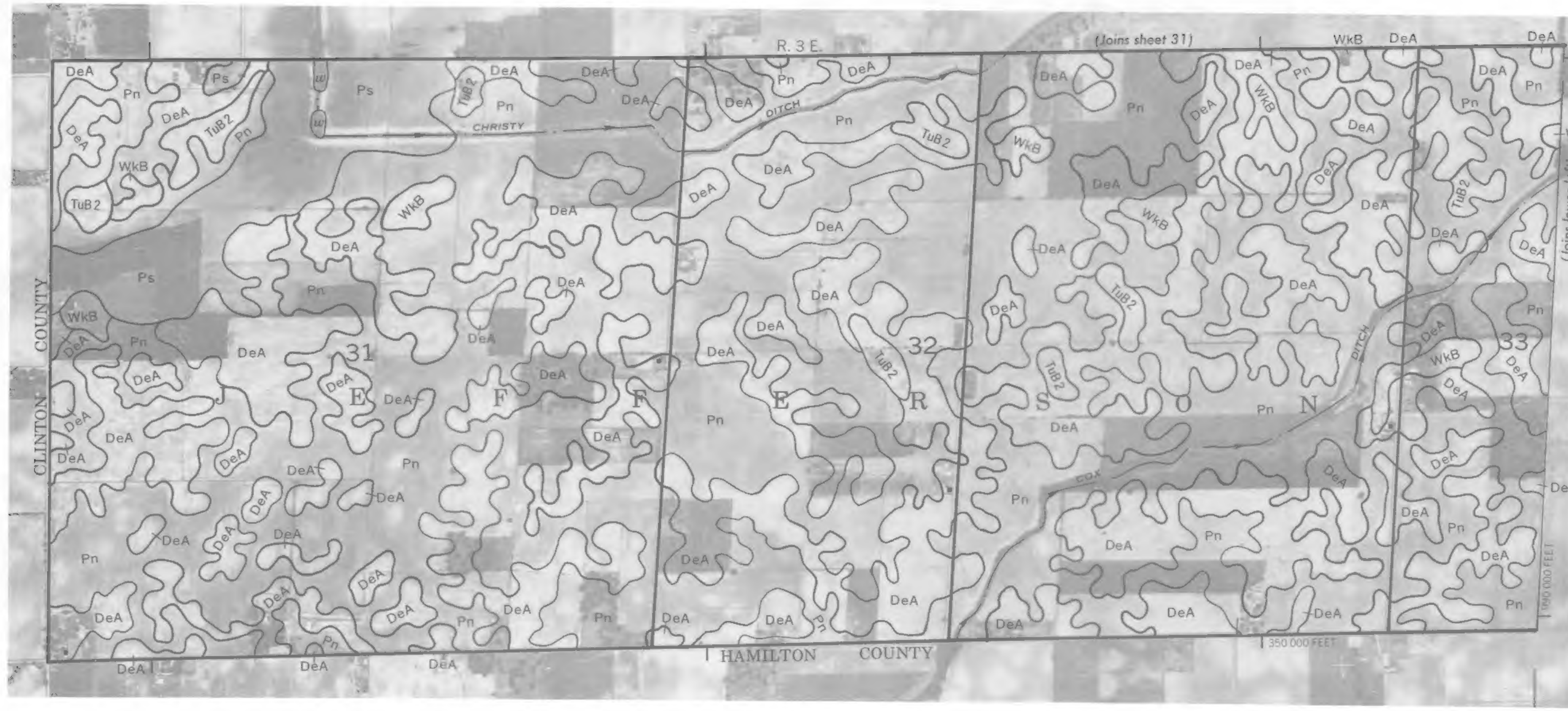
TIPTON COUNTY, INDIANA NO. 35

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

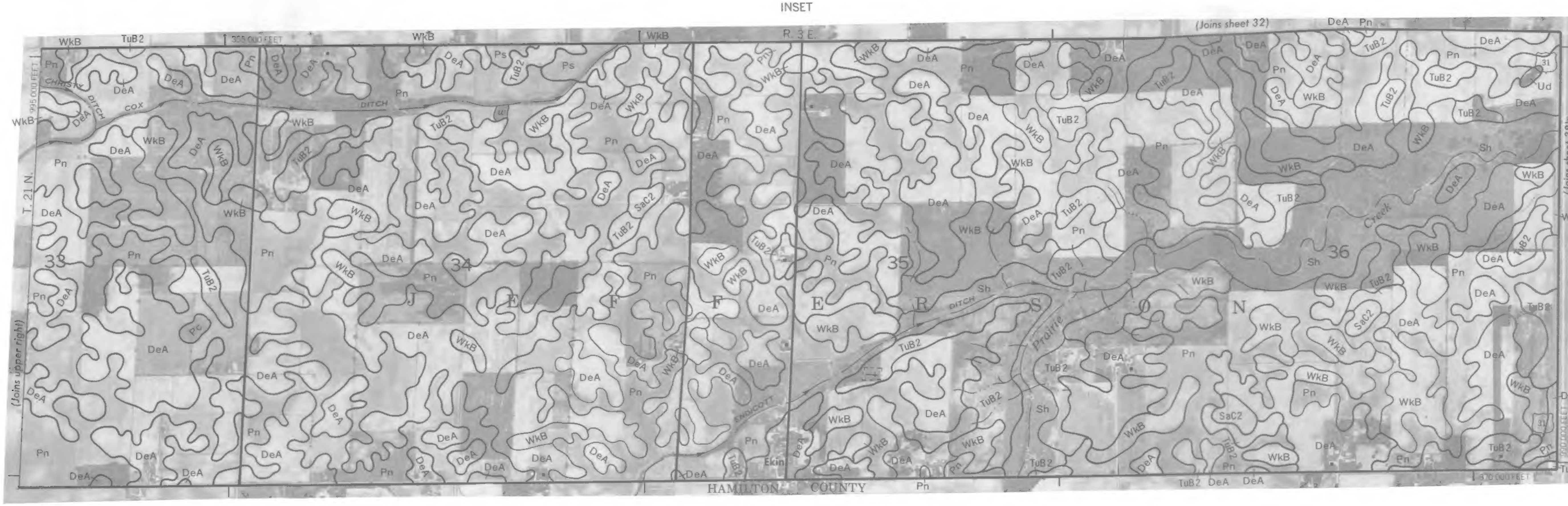

N
MILE
KILOMETER
R. 5 E.
R. 6 E.
T. 21 N.
(Joins sheet 30)
(Joins sheet 35)
(Joins inset, sheet 39)
MADISON COUNTY
New Lancaster
MADISON
445 000 FEET
430 000 FEET
1 000 000 FEET

37

N



INSET

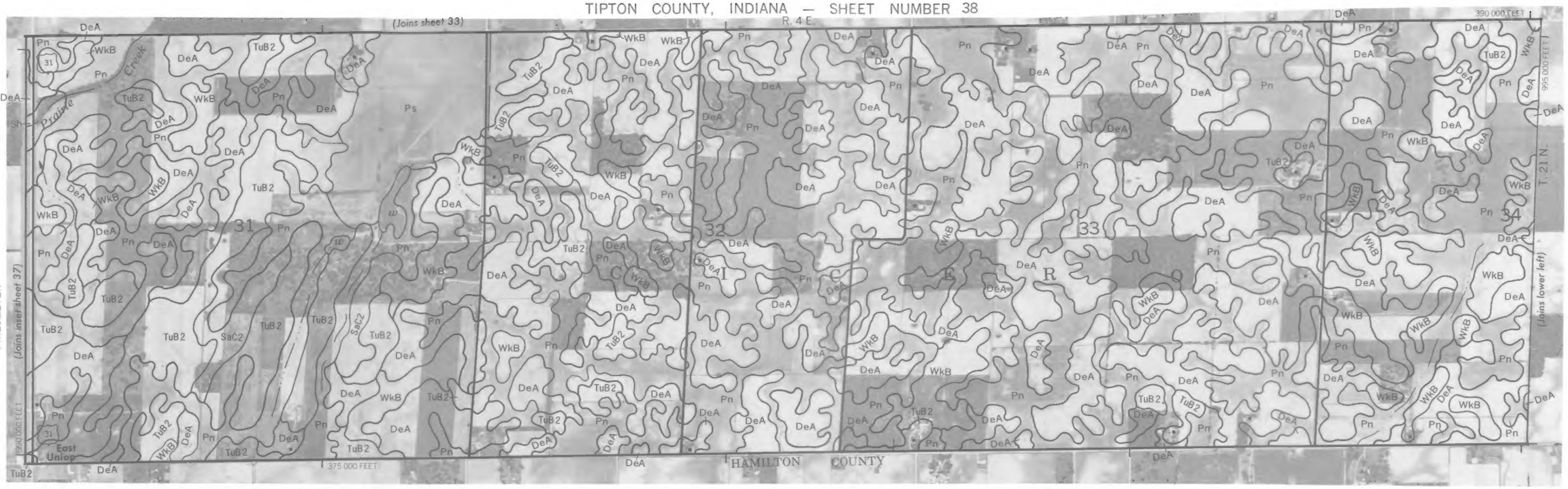


1 MILE
0
1/4
1/2
3/4
1 KILOMETER
0
0.5

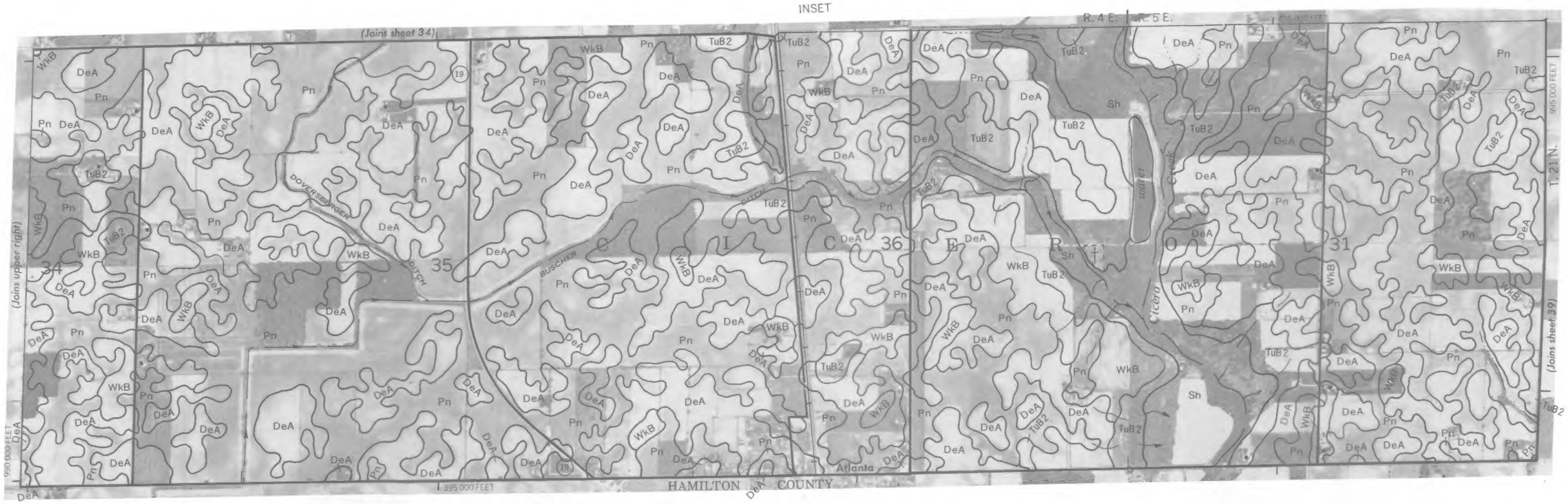
TIPTON COUNTY, INDIANA NO. 37

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

TIPTON COUNTY, INDIANA — SHEET NUMBER 38



INSET

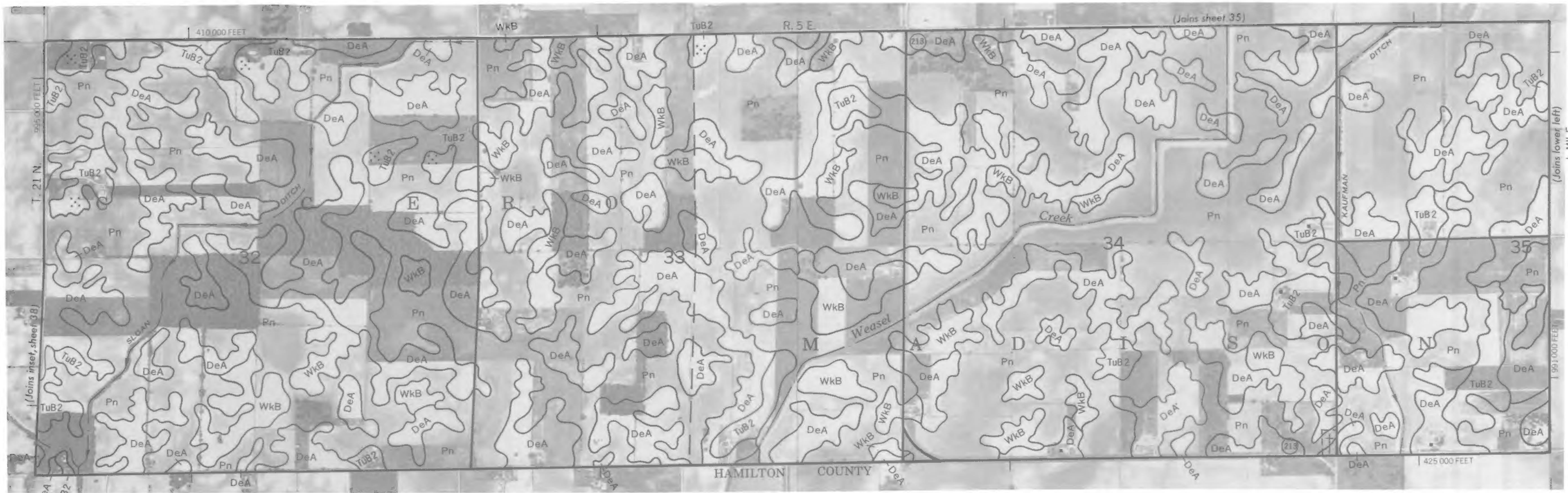


This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

TIPTON COUNTY, INDIANA NO. 38

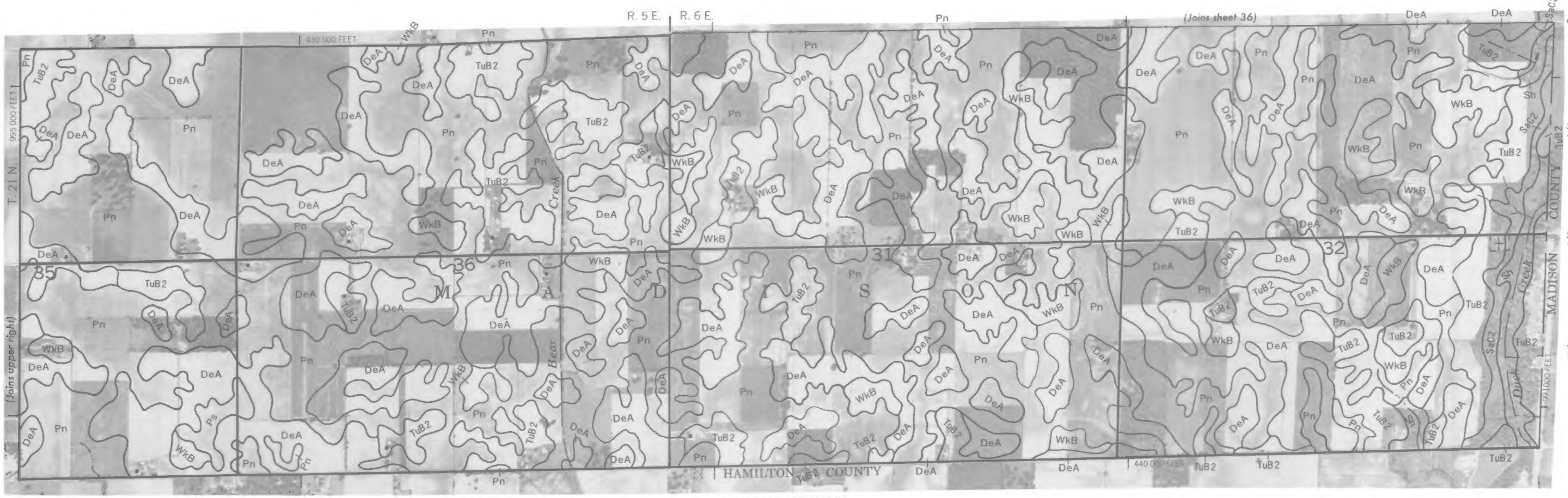
(39)

N



4000 AND 5000-FOOT GRID TICKS

INSET



4000 AND 5000-FOOT GRID TICKS

1 MILE
0
1/4
1/2
3/4
1 KILOMETER
0
0.5

TIPTON COUNTY, INDIANA NO. 39

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.